The professional background of a referring physician predicts the diagnostic yield of small bowel capsule endoscopy in suspected small bowel bleeding

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ABSTRACT

Background and study aims The diagnostic yield of small-bowel capsule endoscopy (SBCE) in suspected small bowel bleeding (SSBB) is highly variable. Different reimbursement systems and equipment costs also limit SBCE use in clinical practice. Thus, minimizing non-diagnostic procedures is advisable. This study aimed to assess the SBCE diagnostic yield and identify factors predicting diagnostic findings in a cohort of patients with SSBB.

Patients and methods In this retrospective cohort study, we analyzed the medical records of patients who consecutively underwent SBCE for SSBB over 9 years. By logistic regression, we identified covariates predicting diagnostic findings at SBCE. Finally, we performed a post-hoc cost analysis based on previous gastroenterologist or endoscopist consultations versus direct SBCE ordering by other specialists.

Results The final analysis included 584 patients. Most SBCEs were ordered by a gastroenterologist or endoscopist (74%). The number of SBCEs without any finding was significantly lower in the gastroenterologist/endoscopist group $P<0.001$). The SBCE diagnostic yield ordered by a gastroenterologist or endoscopist was significantly higher than that by other specialists (63% vs 52%, odds ratio [OR] 1.57; 95% confidence interval [CI] 1.07–2.26, $P=0.019$). At multivariate analysis, older age (OR 1.7, 95%CI 1.2–2.4, $P=0.005$), anemia (OR 4.9, 95%CI 1.9–12, $P=0.001$), small bowel transit time (OR 1, 95%CI 1–1.02, $P=0.039$), and referring physician (OR 1.8, 95%CI 1.1–2.7, $P=0.003$) independently predicted diagnostic findings. Implementing prior gastroenterologist or endoscopist referral vs direct SBCE ordering would reduce medical expenditures by 16%.

Conclusions The professional background of referring physicians significantly improves the diagnostic yield of SBCE and contributes to controlling public health costs.

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Introduction

Since its introduction in clinical practice more than 20 years ago, small-bowel capsule endoscopy (SBCE) has revolutionized the diagnosis and management of small bowel diseases by providing a reliable method for completely visualizing the intestinal mucosal surface.

Several studies have demonstrated SBCE to be superior to less sensitive techniques such as barium follow-through [1], push enteroscopy [2], or other alternative imaging modalities such as computed tomography (CT), enterography, or angiography in diagnosing small bowel pathology [3]. SBCE is equivalent to newer enteroscopy techniques, such as double-balloon enteroscopy [4]. Furthermore, compared with conventional endoscopy, SBCE is a well-tolerated and noninvasive procedure without any need for sedation, with a high completion rate and relatively few contraindications. Consequently, current clinical practice guidelines recommend SBCE as the first-line investigation for patients with small bowel disorders, mainly suspected small bowel bleeding (SSBB), small bowel Crohn's disease, and less frequently polyposis syndromes or celiac disease.

Small bowel bleeding is suspected when a patient presents with gastrointestinal bleeding and negative upper and lower endoscopy findings [5]. It accounts for approximately 5% to 10% of all gastrointestinal bleeding episodes and is associated with increased medical expenditures and resource utilization, including prolonged hospitalizations and excessive procedures. [6].

SBCE has dramatically improved our ability to care for patients with SSBB and has been shown to alter clinical management in 32% to 82% of the cases [7].

However, despite the undeniable advantages, the diagnostic yield of SBCE is still highly variable among the different studies, ranging from 55% to 78% [8, 9]. Moreover, variable reimbursement systems, equipment costs, and time-consuming reading and reporting activity limit the routine use of SBCE in clinical practice [10]. Thus, it is advisable to maximize the diagnostic performance of SBCE by carefully selecting patients and reducing the likelihood of inappropriate procedures.

Based on these premises, we aimed to identify factors predicting SBCE diagnostic yield by retrospectively analyzing a large cohort of patients with SSBB.

Patients and methods

Patients

We retrospectively analyzed the medical records of patients who consecutively underwent SBCE at our tertiary referral center, Federico II University Hospital of Naples, between September 2012 and March 2023.

SSBB was defined as persistent or recurrent bleeding from the gastrointestinal tract and negative findings on high-quality esophagogastroduodenoscopy and colonoscopy and further subdivided into occult and overt bleeding. Occult bleeding was defined as recurrent iron-deficiency anemia or recurrent positive fecal occult blood test results. In contrast, overt bleeding was defined as a recurrent passage of visible blood encompassing melena or hematochezia.

According to the World Health Organization, anemia was defined as a reduction in Hb levels of < 13 g/dL in men or < 12.0 g/dL in non-pregnant women [11]. Anemia was graded according to the National Cancer Institute as follows: "mild (Grade 1), Hb up to 10 g/dL; moderate (Grade 2), Hb between 9.9 to 8.0 g/dL and severe (Grade 3), Hb ≤ 7.9 g/dL" [12].

Inclusion criteria were age > 16 years, previous non-diagnostic standard bidirectional endoscopy, availability of complete laboratory data of interest at the time of the procedure, sufficient bowel cleansing, and visualization of the cecum.

For each patient, we retrieved the following information: age, sex, lowest mean hemoglobin (Hb) value before endoscopic evaluation, hematocrit (HCT), mean corpuscular volume (MCV), mean cell hemoglobin (MCH), and ferritin. Physicians who indicated SBCE were grouped according to their medical speciality: gastroenterologists or endoscopists (G/E) vs. other specialists (OS). We further subdivided G/E into senior G/E (> 10 years' experience) and junior G/E (≤ 10 years' experience). Finally, when possible, we retrieved information on diagnostic work-up, treatment, histopathologic diagnosis, and clinical outcome.

The data analyzed in this study were collected as part of the routine clinical procedure as "not-sensitive". Database management complied with past and present Italian legislation regarding privacy and the current study conformed to the ethical guidelines of the Declaration of Helsinki. According to Italian laws, no specific request and patient approvals are needed for retrospective studies. However, patients provided written informed consent for every diagnostic and therapeutic procedure and a waiver for anonymizing their data in the database.

Capsule endoscopy

All SCBEs were performed in an inpatient or day hospital setting. After an overnight fast and bowel preparation (2 L polyethylene glycol solution given 15 hours before), all patients underwent SBCE with the PillCam SB2 or SB3 system (Given Imaging, Yoqneam, Israel), according to the manufacturer's instructions. The videos were reviewed according to European Society of Gastrointestinal Endoscopy Technical Review [13].

Two expert SBCE readers (DC and CS) independently reviewed video records, and all doubtful findings were discussed and resolved by consensus. SBCE was defined as complete if the capsule passed into the cecum within the recording period. Small bowel cleansing score was assessed by a scale referred to as the Park score, according to which the cleansing score is considered on a scale of 0 to 3, where 3 is better and 0 is worse. Representative images from the small bowel were selected in series at 5-minute intervals, and the two parameters were evaluated in each of the pictures: the proportion of the mucosa visualized (visualization sub-score) and the degree of obscuration by bubbles, debris, bile, or other material (obscuration sub-score). Each parameter was scored on a similar three-point scale, with the visualized mucosa scored as: > 75% = 3, 50% to 75% = 2, 25% to 50% = 1, and < 25% = 0. Similarly, the degree of obscuration was scored as < 5% = 3, 5% to 25% = 2, 25% to 50% = 1, > 50% = 0. The mean score for each of these parameters was obtained by dividing the sum of all the images scored by the total number of images analyzed. Finally, the average of the two parameters was calculated as the overall Park cleansing score [14]. Examinations with visualization <25% were excluded from the final analysis.

The time boundary between the duodenum and the cecum was defined as small bowel transit time (SBTT, min).

Small bowel vascular and inflammatory lesions were described according to the International Delphi consensus panel of expert European SBCE readers [15, 16]. Vascular lesions were further graded according to Saurin classification as P0 (mucosal veins and diverticula without blood or nodules without mucosal breaks), P1 (red spots and small or isolated erosions), and P2 (angiodysplasia, tumors, ulcerative lesions, and varices) based on the potential of clinically significant bleeding [17]. For further analysis, we considered the findings in the P0 and P1 groups as non-diagnostic. Small bowel tumors and polyps were also recorded and considered a significant bleeding source only if they were ≥ 10 mm in size and showed mucosal disruption, bleeding, or bleeding stigmata [18].

The diagnostic yield of SBCE was defined as its capacity for identifying a lesion that is potentially important to patient care concerning the appropriateness of the indication. On the other hand, SBCE was considered negative in the absence of lesions or when the identified findings were insufficient to explain the patient's signs/symptoms.

Statistical analysis

Continuous variables were expressed as mean ± standard deviation (SD) or median and interquartile range (IQR) according to their distribution assessed with the Kolmogorov-Smirnov test. Frequencies were calculated for categorical variables. The Mann-Whitney rank-sum test or Kruskal-Wallis test was used to compare continuous variables. The Chi-square and Fisher's exact test were used to compare the categorical variables.

A univariate analysis was performed to establish whether baseline clinical, laboratory or technical parameters contributed to predicting diagnostic findings. Multivariate analysis of predictive factors of diagnosis at SBCE was then performed by logistic regression with the calculation of odds ratio (OR) and a confidence interval (CI) of 95%.

The interobserver agreement was assessed by using Cohen's kappa (κ) coefficient. The κ index was divided as a slight agreement when the value was < 0.20, fair at 0.21 to 0.40, moderate at 0.41 to 0.60, substantial at 0.61 to 0.80, and almost perfect when > 0.81. $P < 0.05$ was was considered significant. All statistical procedures were performed using SPSS version 22.0 for Windows (SPSS Inc., Chicago, Illinois, United States).

By a post-hoc analysis, based on the results of the multivariate analysis, we performed a cost analysis based on G/E prior consultation versus direct SBCE ordering by OS to estimate the number of avoidable SBCEs, using the Italy DRG-tariff system for the payment of hospital benefits [19]. In detail, DRG code 175 (gastrointestinal bleeding without complications) was applied when SBCE showed the source of bleeding, with a reimbursement of €1884,00. At the same time, DRG code 395 (anemia from an unknown cause) was used when SBCE was negative or inconclusive with a refund of €1645,00. Outpatient G/E consultation (€20,66) was estimated using a tariff system for specialistic consultation. Avoidable SBCEs were calculated assuming a constant number of diagnostic findings (numerator) for the OS group and a stable diagnostic yield for the G/E group. All diagnostic SBCE findings were then assumed to result in a gastroenterologist consultation. To estimate the costs of the G/E consultation paradigm, all patients in the OS group were assumed to receive a G/E consultation. The predicted number of SBCEs was determined by the difference in total SBCEs from the OS group and the estimated avoidable SBCEs. The artwork was created by using GraphPad Prism 5.0.

Results

Among 1067 consecutive SBCEs, 584 procedures performed for SSBB met inclusion criteria and were considered for the statistical analysis. The remaining 483 SBCEs were excluded because they had been performed for indications other than SSBB (n = 364), insufficient bowel preparation (n = 36), inadequate capsule battery time (n = 5), defects in picture transmission (n = 6), and absence of visualization of the cecum at the end of the video recording (n = 72). Clinical and laboratory data of the patients and technical parameters and findings of SBCE are summarized in ▶ **Table 1**.

Half of the patients were male and the median age was 69 years (IQR 58–76). SBCE was indicated by G/E in most cases (74%). The G/E physicians were senior in 63% of the cases and junior in the remaining 37%. The non-G/E referring physicians were medical internists in most cases (34%), followed by cardiologists (18%), hematologists (14%), nephrologists (12%), surgeons (12%), and rheumatologists/immunologists (10%).

Five hundred forty-two patients had occult bleeding, while overt bleeding was present in 42 cases. The median time interval between the event and SBCE was 8 days (IQR 5–13). The median Hb levels were 10.3 g/dL (IQR 9.1–11.4). PillCam SB3 was used in 521 of 584 patients (89%). The median small-bowel transit time was 312 minutes (IQR 212–439).

Diagnostic findings were detected in 354 of 584 patients (61%). Age older than 65 years (P = 0.004), G/E as referring physician (P = 0.020), SBTT (P = 0.016), and Hb levels (P < 0.0001) were significantly associated with diagnostic findings. We did not find significant differences in terms of diagnostic yield among OS nor between senior and junior G/Es. In the multivariate analysis, age older than 65 (OR 1.7, 95%CI 1.2–2.4, P = 0.005), referring physician (OR 1.8, 95%CI 1.2–2.7, P = 0.003), SBTT (OR 1, 95%CI 1–1.02, P = 0.039), and Hb levels (OR 4.9, 95%CI 1.9–12, P = 0.001) independently predicted diagnostic findings at SBCE (▶ **Table 2**).

When we analyzed the studied population according to the referring physician, we found that older age (P = 0.004) and the time interval between the event and SBCE (P = 0.001) were significantly higher in the OS group. As far as laboratory data Hb levels (P = 0.004), rates of mild anemia (P = 0.004) and HCT (P = 0.001) were significantly lower in the OS group whereas ferritin levels (P = 0.001) and rates of moderate anemia (P = 0.007) were significantly lower in the G/E group (▶ **Table 3**).

▶ **Table 1** Clinicopathological characteristics of the patients who underwent SBCE for SSBB according to SBCE findings.

	Total n = 584	**Diagnostic n = 354**	**Not diagnostic n = 230**	**P value**
Males (n, %)	293 (50)	186 (52)	107 (47)	0.155
Age (median, IQR)	69 [58]–[76]	70 [61]–[77]	67 [55]–[75]	0.002
Age > 65 years (n, %)	372 (64)	242 (68)	130 (56)	0.004
Referring physician (n, %)				
Gastroenterologist/endoscopist	432 (74)	274 (77)	158 (69)	0.019
Other specialists	152 (26)	80 (23)	72 (31)	
Bleeding modality (n, %)				
Occult bleeding	542 (93)	327 (92)	215 (93)	0.189
Overt bleeding	42 (7)	27 (8)	15 (7)	
Time interval between event and SBCE, days (median [IQR])	8 [5]–[13]	9 [5]–[14]	8 [5]–[13]	0.793
Pill Cam (n, %)				
SB2	63 (11)	34 (10)	29 (13)	0.253
SB3	521 (89)	320 (90)	201 (87)	
SBTT (min, median [IQR])	312 [212]–[439]	325 [242]–[432]	291 [230]–[388]	0.012
Park score (n, %)				
Score 3	394 (67)	231 (65)	163 (71)	0.075
Score 2	177 (30)	115 (32)	62 (27)	
Score 1	13 (3)	8 (3)	5 (2)	
Hb level (g/dL, median [IQR])	10.3 [9.1–11.4]	10 [8.8–11.1]	10.7 [9.5–11]	0.0001
Anemia (n,%)				
Mild	330 (57)	182 (52)	148 (64)	0.0001
Moderate	212 (36)	136 (38)	76 (33)	00.217
Severe	42 (7)	36 (10)	6 (3)	00.0004
HCT (%, median [IQR])	32.7 [29.2–37.4]	32.7 [29.4–37.5]	33.8 [29.3–38]	0.140
MCV (fL, mean ± SD)	83.2 ± 10.3	82.8 ± 10.1	83.9 ± 10.5	0.241
MCH (pg, median [IQR])	26.8 [23.2–29.2]	26.4 [22.7–29]	26.9 [23.7–29.2]	0.411
Ferritin (ng/mL, median [IQR])	40 [13]–[179]	33 [13]–[152]	51 [11]–[242]	0.591

SSBB, suspected small bowel bleeding; SBCE, small bowel capsule endoscopy; SBTT, small bowel transit time; IQR, interquartile range; Hb, hemoglobin; HCT, hematocrit; MCV, mean corpuscular volume; MCH, mean corpuscular hemoglobin.

The distribution of SBCE findings according to the professional background of the referring physician is shown in ▶ **Fig. 1**. Overall, the number of SBCEs without any finding was significantly lower in the G/E group (P < 0.001), whereas P2 lesions were more frequently diagnosed in the G/E group (P = 0.005). Using Delphi nomenclature, angiectasias were more commonly detected in the G/E group (P = 0.01). Small bowel tumors/polyps were observed in 21 of 274 (8%) in the G/E group and four of 80 (5%) in the OS group, respectively (P = 0.568).

Overall, the interobserver agreement between the two SBCE readers was almost perfect (κ = 0.89).

Following SBCEs, individual decisions were made. Most patients with angioectasias had argon plasma coagulation or were medically treated with a somatostatin analog.

Finally, by a post-hoc cost analysis, based on DRG code 175, we estimated an overall reimbursement of €666,936 for the 354 subjects with diagnostic results. For the 230 patients with a negative SBCE, using the DRG code 395, we estimated an overall reimbursement of €378,350. Therefore, the total refund for patients undergoing SBCE for SSBB was 1.044.746 (€1789 per patient).

▶ **Table 2** Univariate and multivariate analysis of factors predictive of diagnostic findings in SSBB.

	Univariate			**Multivariate**		
Variable	**P value**	**OR**	**95 % CI**	**P value**	**OR**	**95% CI**
Gender	0.155	1.3	0.9–1.8			
Age > 65 years	0.004	1.7	1.2–2.3	.005	1.7	1.2–2.4
Referring physician	0.020	1.6	1–2.2	.003	1.8	1.2–2.7
Bleeding modality	0.614	1.2	0.6–2.2			
Time interval between event and SBCE	0.626	1	0.9–1.03			
Capsule type	0.254	1.3	0.8–2.3			
SBTT	0.016	1	1–1.03	.042	1	1–1.03
Parks score	0.615	1	0.8–1.4			
Anemia grading						
Mild	0.001	1		.001	1	
Moderate	0.038	1.4	1–2	.030	1.5	1–2.2
Severe	0.000	4.9	2–12	.001	4.9	1.9–12
HCT	0.336	1	0.9–1.01			
MCV	0.240	1	0.9–1			
MCH	0.735	1	0.9–1			
Ferritin	0.168	1	0.9–1			

SSBB, suspected small bowel bleeding; OR, odds ratio; CI, confidence interval; SBCE, small bowel capsule endoscopy; SBTT, small bowel transit time; HCT, hematocrit; MCV, mean corpuscular volume; MCH, mean corpuscular hemoglobin.

Assuming a constant number of diagnostic SBCEs (n = 80) for the OS group and a stable diagnostic yield of the G/E group (63%), an estimated 127 SBCEs would have been ordered by the G/E group to find the same pathology. This estimation would result in 25 SBCEs being avoided. The OS group ordered 152 SBCEs, with diagnostic findings in 80 patients (52%) who would have most likely had a subsequent G/E consultation. The estimated SBCE medical cost indicated by OS was €273.580 (€ 277.928 for SBCE and €1652.80 for G/E consultation). Should all patients in the OS group have undergone a G/E consultation before SBCE (gastroenterologist consultation paradigm), the group would have had 152 G/E consultations with 127 SBCEs. This paradigm would have resulted in an estimated total medical cost of € 230.343, representing a 16% reduction in medical expenditures in performing SBCE for SSBB (▶ **Fig. 2**).

Discussion

In our study, the SBCE diagnostic yield, defined as the likelihood that a test or procedure will provide the information needed to establish a diagnosis, was 61%.

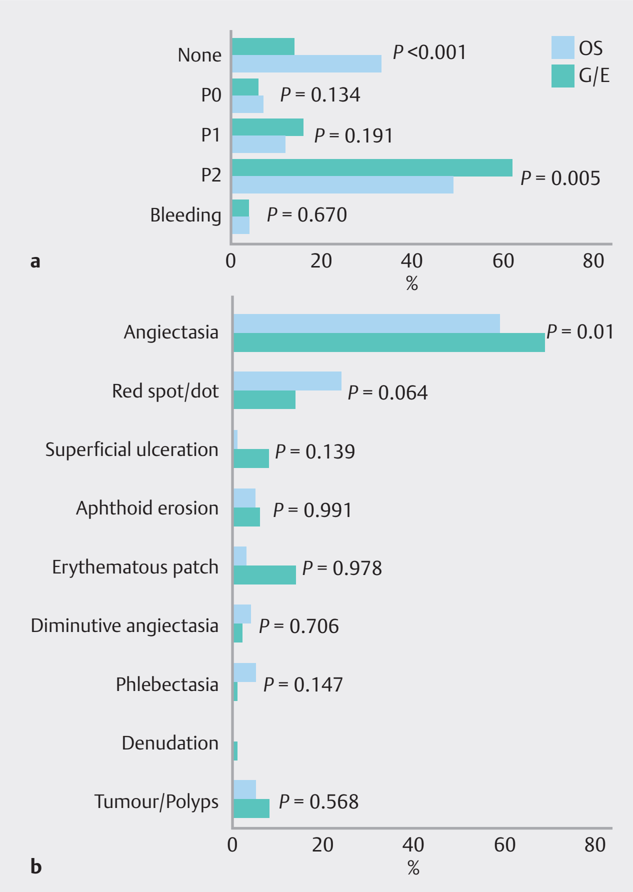
In recent years, several studies aimed to identify factors potentially impacting the diagnostic yield of SBCE in different clinical scenarios, but the results are still far from conclusive.

One of the principal confounders is the unstandardized definition of the diagnostic yield. Indeed, any pathological findings not directly related to the indication to perform SBCE should be considered irrelevant in the diagnostic yield estimation [20]. For instance, if we had considered all positive findings, the SBCE diagnostic yield would have been overestimated by 7%.

Another issue relevant to the diagnostic performance of SBCE is interobserver agreement on detection rate and finding classification. A recent metanalysis [21] found that the overall pooled estimates for "perfect" or "good" interobserver and intra-observer agreement were only 23% and 37%, respectively. The reader's experience, accumulating fatigue, and lack of standardization in describing small bowel lesions could affect the interobserver bias [22, 23, 24].

In our study, all the video recordings were reviewed by two expert readers who described SBCE findings according to the International Delphi Consensus, one of the most accurate and validated processes for answering questions that cause uncertainty even among experts, getting an almost perfect agreement (k = 0.89).

Patient demographic and clinical factors, such as sex, age, bleeding modality, and type of lesion, can also affect the diagnostic yield of SBCE. Male patients were more likely to exhibit significant findings on SBCE examinations because of a higher prevalence of angiodysplasia [25]. In a large retrospective study



▶ **Fig. 1** Distribution of SBCE findings according to the professional background of the referring physician by using a Saurin classification and b the International Delphi consensus panel of expert European SBCE readers. Panel B also includes detected tumors/polyps. G/E, gastroenterologist/endoscopist; OS, other specialists.

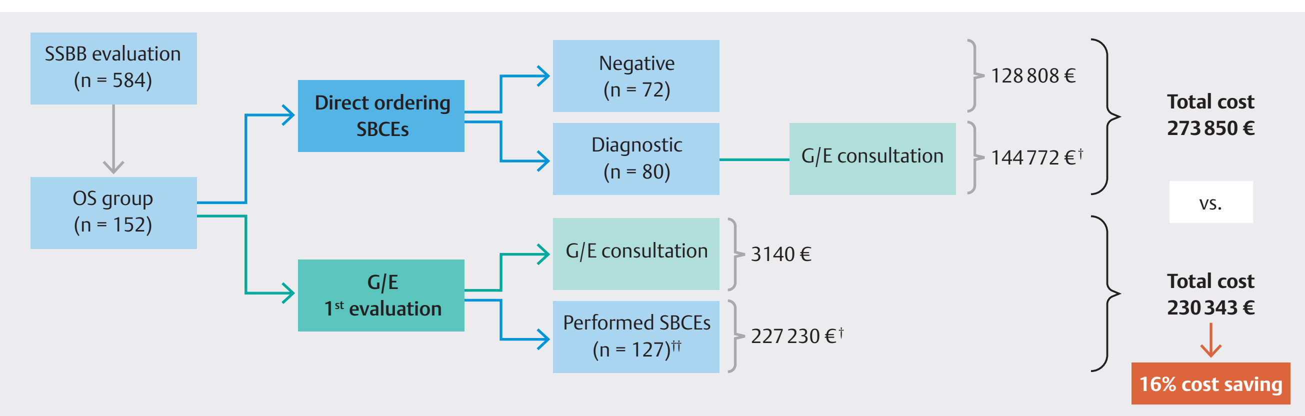
on 1008 consecutive patients, the SBCE diagnostic yield was significantly higher in patients aged ≥ 70 years compared with younger subjects, particularly in the SSBB setting [26]. Among 512 patients with SSBB, diagnostic findings were reported in 350 patients (68.4%) and angioectasias were documented in 153 (43.7%) [27].

According to literature data in our cohort of SSBB patients, diagnostic findings were significantly more frequent in patients with advanced age ($P = 0.004$), whereas angiodysplastic lesions were more frequently diagnosed in males (36% vs. 28%, $P = 0.045$).

Laboratory data have also been proven crucial in determining the diagnostic yield of SBCE. Indeed, Hb level was the only variable associated with positive findings ($P = 0.005$) among 123 patients who underwent SBCE for iron-deficiency anemia [28]. More recently, a retrospective multicenter study that included 765 SBCEs performed for iron deficiency anemia found increased rates of positive procedures in patients with lower mean Hb levels [29].

Not surprisingly, in our study, Hb levels strongly predicted diagnostic findings ($P = 0.001$), especially in the case of severe anemia (OR 4.9).

A history of overt bleeding was also strongly associated with the diagnostic yield of SBCE performed for SSBB. In a prospective study including 100 consecutive patients who underwent SBCE for SSBB, the diagnostic yield decreased from 92% in overt bleeding to 44% in occult and 13% in previous overt bleeding [30]. Moreover, the time interval between the bleeding episode and the SBCE examination can also impact the diagnostic yield of SBCE. A retrospective study demonstrated that deployment of SBCE within 3 days of admission in patients with overt SSBB resulted in a higher diagnostic yield, therapeutic intervention rate, and decreased length of hospital stay [31]. A recent meta-analysis involving 39 studies confirmed that the shorter the time of SBCE examination, the higher the pooled diagnostic



▶ **Fig. 2** Cost analysis comparing prior gastroenterologist/endoscopist consultation vs. direct ordering of SBCE in SSBB setting (gastroenterologist consultation paradigm). G/E, gastroenterologist/endoscopist; SBCE, small bowel capsule endoscopy; SSBB, suspected small bowel bleeding; OS, other specialists. †Mean SBCE reimbursement was € 1789 per patient. G/E consultation was €20,66. ††Assuming a constant number of diagnostic SBCE findings and a stable diagnostic yield of the G/E group.

▶ **Table 3** Clinicopathological characteristics of the patients who underwent SBCE for SSBB according to the referring physician.

	G/E n. 432	OS n. 152	P value
Males (n, %)	210 (49)	83 (55)	0.239
Age (median, IQR)	68 [57]–[76]	72 [62]–[78]	0.004
Age > 65 years (n, %)	263 (61)	109 (72)	0.022
Bleeding modality (n, %)			
Occult bleeding	402 (93)	140 (92)	0.835
Overt bleeding	30 (7)	12 (8)	
Time interval between event and SBCE, days (median [IQR])	7 [4]–[11]	12 [6]–[18]	0.0001
Pill Cam (n, %)			
SB2	43 (10)	20 (13)	0.345
SB3	389 (90)	132 (87)	
SBTT (min, median [IQR])	321 [240]–[418]	294 [230]–[403]	0.498
Park score (n, %)			
Score 3	300 (70)	94 (62)	0.227
Score 2	123 (28)	54 (36)	
Score 1	9 (2)	4 (2)	
Hb level (g/dL, median [IQR])	10.4 [9]–[12]	9.7 [9]–[11]	0.004
Anemia (n,%)			
Mild	231 (53)	60 (39)	0.004
Moderate	166 (38)	78 (51)	0.007
Severe	35 (9)	14 (10)	0.799
HCT (%, median [IQR])	33.6 [29.7–38]	30.2 [27.4–35]	0.0001
MCV (fL, mean ± SD)	83.1± 9.9	83.7 ± 11.2	0.578
MCH (pg, median [IQR])	26.8 [23.2–29]	26.9 [23.5–29.7]	0.744
Ferritin (ng/mL, median [IQR])	32 [12]–[136]	105 [17]–[242]	0.0001

G/E, gastroenterologist /endoscopist; OS, other specialists.

yield [32]. Accordingly, current guidelines state that SBCE should be performed as soon as possible after bleeding [5].

In our study, the diagnostic yield of SBCE was slightly but not significantly higher for overt than occult SSBB (71% vs 60%, *P* = 0.189) and independent of the timing of the examination. The lack of an emergency department at our hospital likely accounts for the small number of SBCEs performed for overt SSBB and the long time interval between the event and SBCE recorded in our population.

Finally, procedure-related factors, including SBTT and small bowel cleansing, could influence the diagnostic yield of SBCE. The analysis of 1,433 SBCE procedures prospectively collected from 30 participating centers in the Lombardy Registry found a longer SBTT associated with a higher detection rate for significant lesions in SSBB patients [33]. Nevertheless, small bowel cleansing does not seem to affect SBCE diagnostic rates. A prospective, multicenter, randomized controlled trial on 834 consecutive patients undergoing SBCE for SSBB concluded that the cleansing quality did not improve the diagnostic yield of the procedure [34].

In line with the literature data, in our study, SBTT independently predicted diagnostic findings at SBCE (*P* = 0.039), while we did not observe differences in small bowel cleansing scores between patients with a diagnostic SBCE compared with those in whom the procedure failed to detect a bleeding source. However, we excluded from the analysis all the records with insufficient cleanliness (Park score 0), and only 13 patients with a Park score of 1 were included.

Mounting evidence has shown that open-access gastrointestinal endoscopy without prior consultation with a dedicated specialist has resulted in inappropriate endoscopies and overutilization of limited healthcare resources [35]. Very few studies have explored the effects of an open-access approach on the diagnostic yield of SBCE. However, an appropriate indication to perform SBCE is associated with significantly higher diagnostic performance [34]. When two dedicated gastroenterologists reassessed the indication in 50 patients who underwent SBCE for SSBB, the diagnostic yield was higher (> 92%) than that reported in the published literature, and 37% of the procedures were avoided [35].

Interestingly, in our study, beyond the factors expected to be related to the diagnostic yield, we found that the referring physician was an independent predictor of diagnostic findings at SBCE (OR 1.8, 95%CI 1.2–2.7, $P = 0.003$). Overall, the number of SBCEs without any finding was significantly lower in the G/E group ($P < 0.001$), while P2 lesions were more frequently diagnosed in the G/E group ($P = 0.005$), despite older age ($P = 0.004$) and lower Hb levels ($P = 0.004$) in the OS group.

These results support the need for proper selection of patients who undergo SBCE for SSBB made by experienced and dedicated physicians, mainly considering the growing attention of the medical community to controlling and streamlining public health costs.

The cost-effectiveness of SBCE is challenging, depending on several factors such as the health system model, inpatient vs. outpatient setting, insurance coverage, facility and physician fees, and length of hospital stay. In the Italian health system, only procedures included in the dedicated regional "reimbursed outpatient procedure list" are reimbursed. Thus, especially in administrative regions such as the Campania, where SBCE is not reimbursed, or in an open referral system, careful selection of patients to maximize the diagnostic performance of SBCE becomes crucial. Referring physicians may represent the turning point from this cost-consciousness perspective. Indeed, our cost analysis using the G/E consultation model rather than direct SBCE ordering estimated a 16% reduction in medical costs for the most common indication, SSBB.

We are aware that our study had several limitations. First, it was retrospective and conducted in a single center. Thus, it is conceivable that several variables were not controlled for. Moreover, the lack of an emergency department in our hospital could have biased the selection of our patients. On the other hand, our experience reflects what usually happens in a real-life context. Still, the large cohort of patients analyzed and the rigorous methodological approach strengthened our results.

Conclusions

It is challenging to draw definitive conclusions from our study due to insufficient data. Nevertheless, our findings underscore the value of appropriate assessment of the indication for SBCE by a dedicated physician to optimize the diagnostic yield of the procedure. Establishing dedicated clinics and/or implementing educational programs for training referring physicians could ensure the appropriate use of this powerful diagnostic tool and contribute to delivering cost-effective and high-quality medical care. Prospective multicenter studies would confirm our results and assess, where appropriate, the effects of the programs adopted to overcome this drawback.

Conflict of Interest

The authors declare that they have no conflict of interest.

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