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Practices and perceptions of 5-aminosalicylic acid use in Crohn's disease: a nationwide survey of physicians in Korea by KASID Guidelines Taskforce Team

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Background/Aims: Despite international guidelines recommending against the use of 5-aminosalicylic acid (5-ASA) for Crohn's disease (CD), it remains widely prescribed. This study aimed to investigate current patterns of 5-ASA use and physicians' perceptions of its efficacy among Korean specialists. **Methods:** A nationwide online survey was conducted in August 2025 targeting Korean gastroenterologists and colorectal surgeons managing inflammatory bowel disease. The questionnaire included 19 items addressing prescribing behaviors, perceived efficacy, and clinical decision-making regarding 5-ASA in CD. **Results:** A total of 118 out of 124 physicians (95.2%) responded to the survey. The majority (67.8%) reported prescribing 5-ASA to more than half of their patients with CD. Standard to high doses (>2 g/day) were commonly used (94.9%), and time-dependent formulations were preferred (92.4%). Although 55.1% used 5-ASA irrespective of disease location, it was frequently prescribed for colonic/ileocolonic disease (57.7%). Physicians primarily used 5-ASA in cases of non-active or mildly active CD. Notably, over 70% of respondents perceived 5-ASA to have a marginal yet beneficial effect on clinical remission, biomarker improvement, and mucosal healing. Approximately one-third of physicians reported continuing 5-ASA even after initiating biologics or small molecules. **Conclusions:** This survey reveals a substantial gap between clinical guidelines and current practice in Korea regarding 5-ASA use for CD. Many physicians continue to view 5-ASA as a relevant option, particularly for patients with low inflammatory burden. These discrepancies likely reflect practical factors such as clinical experience and drug characteristics, which should be carefully considered before excluding 5-ASA from CD management. **(Intest Res 2025;23:491-501)**

Key Words: Practice guidelines as topic; Crohn disease; Mesalamine; Surveys and questionnaires; Efficacy

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INTRODUCTION

Crohn's disease (CD) is a chronic, immune-mediated inflammatory bowel disease (IBD) characterized by transmural inflammation that can affect any part of the gastrointestinal tract.[1] It commonly follows a relapsing-remitting course and may lead to progressive bowel damage and systemic complications.[2] The incidence and prevalence of CD are increasing globally, including in Asia, contributing to a rising disease burden.[3,4] In recent years, the therapeutic landscape has expanded with the introduction of biologics and small molecule agents, offering more diverse treatment options.[5] The management paradigm of IBD has evolved from symptom-based approaches to more proactive strategies emphasizing early intervention and tight disease control. The concept of treat-to-target defining specific treatment goals at each disease stage and adjusting therapy, accordingly, has become a central framework in optimizing long-term outcomes in patients with CD.[6]

5-Aminosalicylates (5-ASAs) have long been used as a first-line treatment for CD, particularly in patients with mild to moderate disease.[7,8] They remain widely prescribed due to their favorable safety profile and good tolerability. However, recent guidelines from the European Crohn's and Colitis Organisation (ECCO) and the American Gastroenterological Association (AGA) recommend against the use of 5-ASAs for either induction or maintenance of remission in CD.[9,10] These recommendations are based on older studies that focused primarily on clinical remission, without fully considering more recent treatment goals such as biomarker improvement and mucosal healing. In real-world practice, some patients present with quiescent or mild diseases that do not require the use of corticosteroids or immunosuppressive agents. In such cases, 5-ASAs, despite their marginal effect, may still be considered a treatment option.

This gap between guideline recommendations and real-world practice suggests a need for better understanding of how 5-ASAs are actually used. We conducted a nationwide survey to investigate current prescribing patterns and physicians' perceptions of 5-ASA efficacy in Korean patients with CD. The results may help inform future updates to treatment guidelines.

METHODS

1. Survey

The survey comprised 19 questions categorized into 4 domains: baseline characteristics of participants (5 items), patterns of 5-ASA use in clinical practice for CD (7 items), perceptions regarding the efficacy of 5-ASA in CD (5 items), and other relevant aspects (2 items). The questionnaire was developed by a panel of 9 expert gastroenterologists who were members of the Korean Association for the Study of Intestinal Diseases (KASID) Guideline Task Force Team. The full questionnaire is provided in Supplementary Material 1.

The survey was distributed online to 124 physicians in Korea, including gastroenterologists and colorectal surgeons, who work at academic hospitals and specialize in lower gastrointestinal diseases, particularly IBD. Using Google Forms, the survey was administered via a mobile phone invitation, with a unique link individually sent by text message to physicians registered with KASID. The preface of the questionnaire clearly stated that the survey was intended for medical research. Participation was considered to imply informed consent, as respondents voluntarily completed the survey after being adequately informed of its purpose. All responses were submitted via a single web page using a "submit" button, which could only be accessed through the personalized survey link, thereby minimizing the possibility of responses from uninvited individuals. The data collection period lasted from August 8 to August 21, 2025, during which a total of 118 responses were collected. All questions were mandatory, and all respondents completed the entire survey.

The survey results were subsequently discussed and interpreted through an online meeting involving 9 expert members of the KASID Guideline Task Force Team. We conducted subgroup analyses based on respondents' clinical experience (<10 years vs. ≥ 10 years) and outpatient volume (<100 IBD patients seen over the past 3 months vs. ≥ 100 IBD patients seen over the past 3 months) for each survey item. This study was approved by the Institutional Review Board of Daegu Catholic University Medical Center (IRB No. DCUMC 2025-06-003).

2. Statistical Analysis

Categorical variables are presented as numbers and percentages and analyzed using the chi-square test or Fisher exact test. A two-sided P-value <0.05 was considered statistically significant. All analyses were performed using IBM SPSS Statistics 21.0 for Windows (IBM Corp., Armonk, NY, USA).

RESULTS

1. Survey Participants

A total of 118 out of 124 physicians (95.2%) responded to the

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survey. The age distribution was as follows: 20.3% were aged 40–44 years, 18.6% were aged 35–39 or 45–49 years, 16.9% were aged 50–54 years, 14.4% were aged 55–59 years, 6.8% were younger than 35 years, and 4.2% were over 60 years. Of the respondents, 65.3% (n=77) were male and 34.7% (n=41) were female. Most respondents (97.5%) were gastroenterologists, while 2.5% were surgeons. Regarding clinical experience with IBD, 32.2% had been managing IBD patients for 10–19 years, 31.4% for less than 5 years, 18.6% for 20–29 years, and 16.9% for 5-9 years. In terms of clinical volume, 44.9% of respondents reported managing fewer than 100 CD outpatients over the past 3 months, followed by 16.1% who saw 100–199 patients, 19.5% who saw 200–299 patients, and 19.5% who saw more than 300 patients during the same period. Respondents were distributed across all major regions of Korea, supporting the nationwide representativeness of the survey (Table 1).

Table 1. Baseline Characteristics of the Survey Respondents

Characteristic	No. of patients (%)
Age (yr)	
<35	8 (6.8)
35–39	22 (18.6)
40–44	24 (20.3)
45–49	22 (18.6)
50–54	20 (16.9)
55–59	17 (14.4)
≥60	5 (4.2)
Sex	
Male	77 (65.3)
Female	41 (34.7)
Specialty	
Gastroenterologist	115 (97.5)
Surgeons	3 (2.5)
Duration of IBD care experience (yr)	
<5	37 (31.4)
5–9	20 (16.9)
10–19	38 (32.2)
20–29	22 (18.6)
≥30	1 (0.8)
No. of CD outpatients over 3 mo	
<100	53 (44.9)
100–199	19 (16.1)
200–299	23 (19.5)
300–399	10 (8.5)
≥400	13 (11.0)
Region	
Seoul and Metropolitan area	58 (49.2)
Yeongnam	33 (27.9)
Chungcheong	12 (10.2)
Honam	11 (9.3)
Gangwon and Jeju	4 (3.4)

IBD, Inflammatory bowel disease; CD, Crohn's disease.

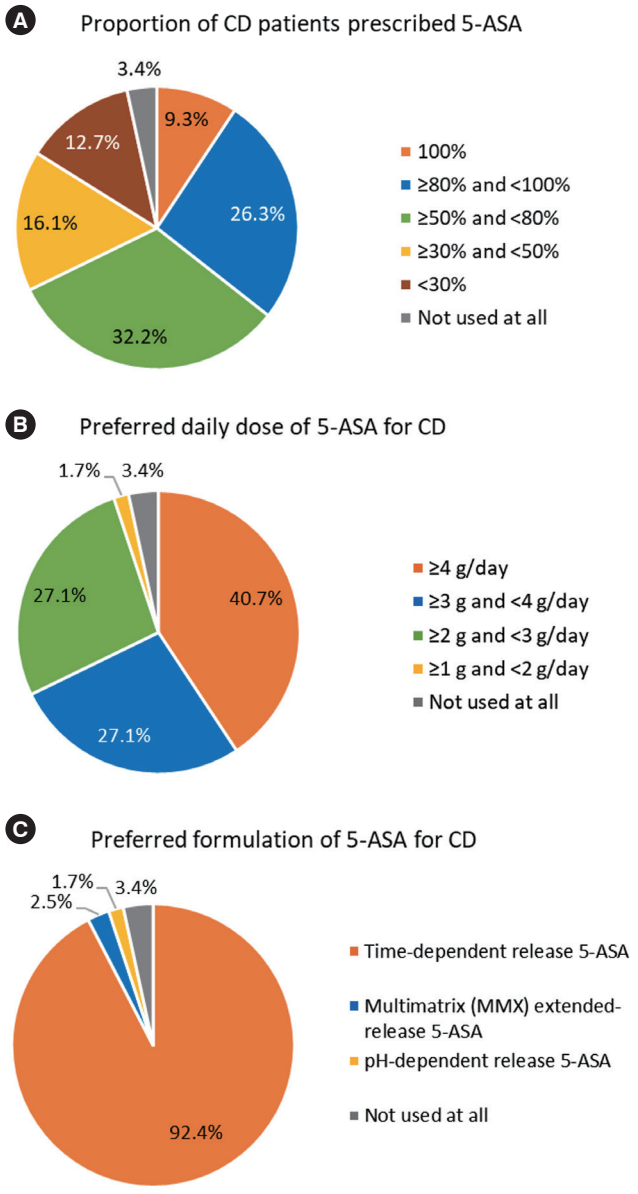

Fig. 1. Prescription patterns of 5-ASA for CD. (A) Proportion of patients with CD prescribed 5-ASA. (B) Preferred daily dose of 5-ASA prescribed to patients with CD. (C) Preferred formulation of 5-ASA prescribed to patients with CD. CD, Crohn's disease; 5-ASA, 5-aminosalicylate.

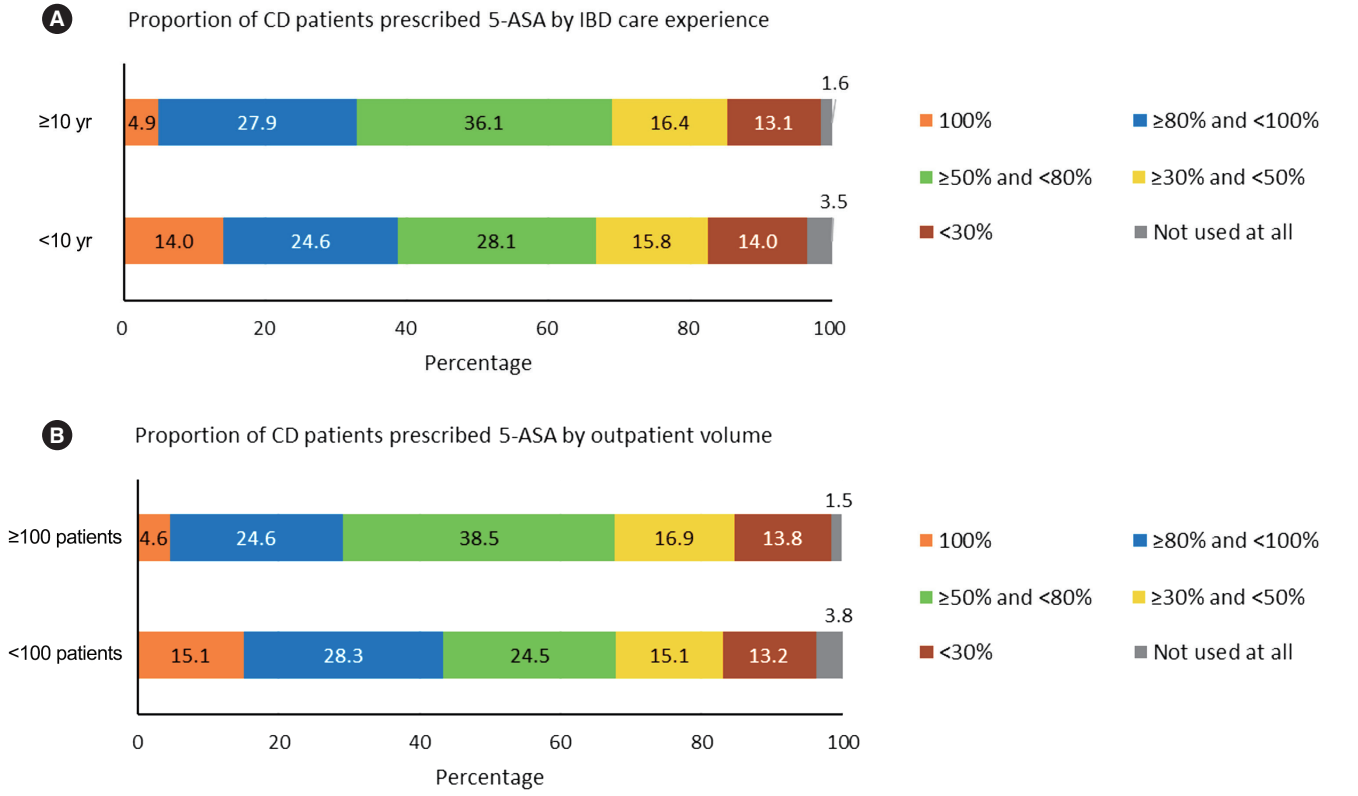

Fig. 2. Proportion of CD patients prescribed 5-ASA by physician subgroup. (A) Subgroups based on IBD care experience (< 10 years vs. ≥10 years). (B) Subgroups based on outpatient volume in the past 3 months (< 100 patients vs. ≥ 100 patients). Each bar shows the distribution of responses regarding the proportion of CD patients prescribed 5-ASA. CD, Crohn's disease; 5-ASA, 5-aminosalicylate; IBD, inflammatory bowel disease.

2. Patterns of 5-ASA Use in Clinical Practice for CD

1) 5-ASA Prescription Patterns in Clinical Practice

Despite ongoing debate regarding the efficacy of 5-ASA in CD, a substantial proportion of physicians reported actively prescribing 5-ASA to their patients. Specifically, 67.8% of respondents indicated that they use 5-ASA in more than half of their CD patients, and among them, 9.3% reported prescribing 5-ASA to all their CD patients. Only a small minority (3.4%) stated that they do not use 5-ASA at all in CD management (Fig. 1A). Further subgroup analyses showed that the proportion of CD patients prescribed 5-ASA did not significantly differ according to physician experience (< 10 years vs. ≥10 years) or outpatient volume (< 100 patients in 3 months vs. ≥ 100 patients in 3 months) (Fig. 2).

Regarding dosing practices, 40.7% of physicians preferred a daily dose of ≥4 g, and 27.1% each favored 3–4 g/day or 2–3 g/day, suggesting that most clinicians who use 5-ASA tend to prescribe it at standard to high doses. Very few respondents (1.7%) reported using low-dose regimens (< 2 g/day) (Fig. 1B). Subgroup analyses showed that physicians with ≥10 years of IBD experience were significantly less likely to prefer high-dose 5-ASA (≥4 g/day) compared to those with < 10 years of experience (29.5% vs. 52.6%, $P=0.015$), while no significant differences were observed based on outpatient volume (Supplementary Fig. 1).

As for formulation preference, an overwhelming majority (92.4%) of respondents favored the time-dependent release formulation, while only a small proportion selected multimatrix extended-release (2.5%) or pH-dependent release forms (1.7%) (Fig. 1C). In subgroup analyses, the time-dependent release formulation remained the overwhelmingly preferred choice across all subgroups (Supplementary Fig. 2).

2) Prescribing Patterns of 5-ASA by Disease Phenotype and Activity

Prescribing patterns of 5-ASA among clinicians varied by disease phenotype, and disease activity. Regarding disease location, 55.1% of respondents reported prescribing 5-ASA regardless of anatomical involvement. Among those who tailored 5-ASA use based on disease location, 29.7% of respondents

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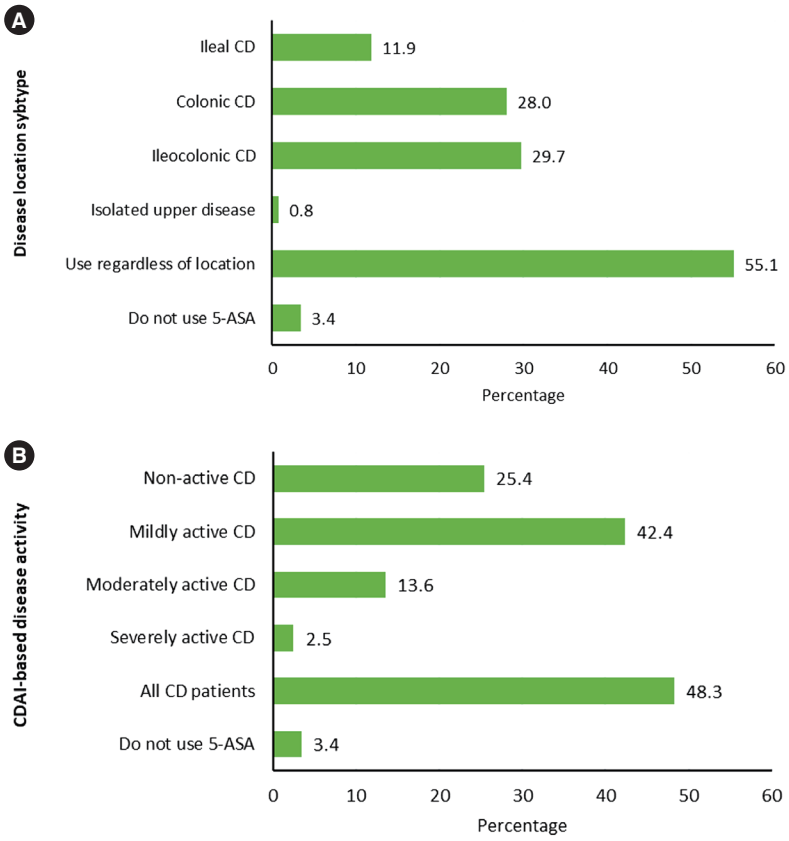

Fig. 3. 5-ASA prescription patterns by disease location and activity in CD. (A) Use of 5-ASA by disease location. Analysis of answers to the following questions: "If you tailor 5-ASA use by disease location, in which types of CD do you prescribe it? (You may select multiple options. However, if you choose 'Use regardless of location' or 'Do not use 5-ASA', please do not select any other options)." (B) Use of 5-ASA according to disease activity at diagnosis. Analysis of answers to the following questions: "At the time of CD diagnosis, in which disease activity states do you prescribe 5-ASA? (You may select multiple options. However, if you choose "Use regardless of location" or "Do not use 5-ASA," please do not select any other options)." CD, Crohn's disease; 5-ASA, 5-aminosalicylate; CDAI, Crohn's Disease Activity Index.

used it for ileocolonic disease, 28.0% of respondents for colonic disease, and 11.9% of respondents for ileal disease (Fig. 3A).

In terms of disease activity by Crohn's Disease Activity Index (CDAI), nearly half of respondents (48.3%) reported using 5-ASA in all CD patients, irrespective of disease activity. Among those who tailored 5-ASA use based on disease activity, 42.4% reported its use in mildly active disease (CDAI 150–220), while 25.4% reported using it in non-active disease (CDAI <150). In contrast, 13.6% of respondents reported using 5-ASA in moderately active disease (CDAI 220–450), and 2.5% reported its use in severely active disease (CDAI >450) (Fig. 3B). In subgroup analyses based on physicians' experience and clinical volume, the patterns of 5-ASA use according to disease location and disease activity did not differ significantly between groups (Supplementary Figs. 3 and 4).

Among respondents who reported using 5-ASA in patients with mildly active or non-active disease, a follow-up question was asked regarding their prescribing behavior based on endoscopic or imaging findings. Of these, 92.3% reported using 5-ASA when mild lesions were observed—defined as aphthous or shallow ulcers confined to the terminal ileum or an equivalently limited area, without complications such as strictures or fistulas. In contrast, 42.9% reported using 5-ASA even when the lesions were more extensive or severe than shallow ulcers, involving a broader area but still without complications such as strictures or fistulas.

3) Discontinuation of 5-ASA

Discontinuation patterns of 5-ASA also varied by treatment escalation. The most common situation for stopping 5-ASA was the initiation of biologic therapies (49.2%), followed by initiation of small molecule agents (29.7%) and immunomodulators (16.9%). However, a substantial proportion (33.1%) of respondents reported continuing 5-ASA regardless of treat-

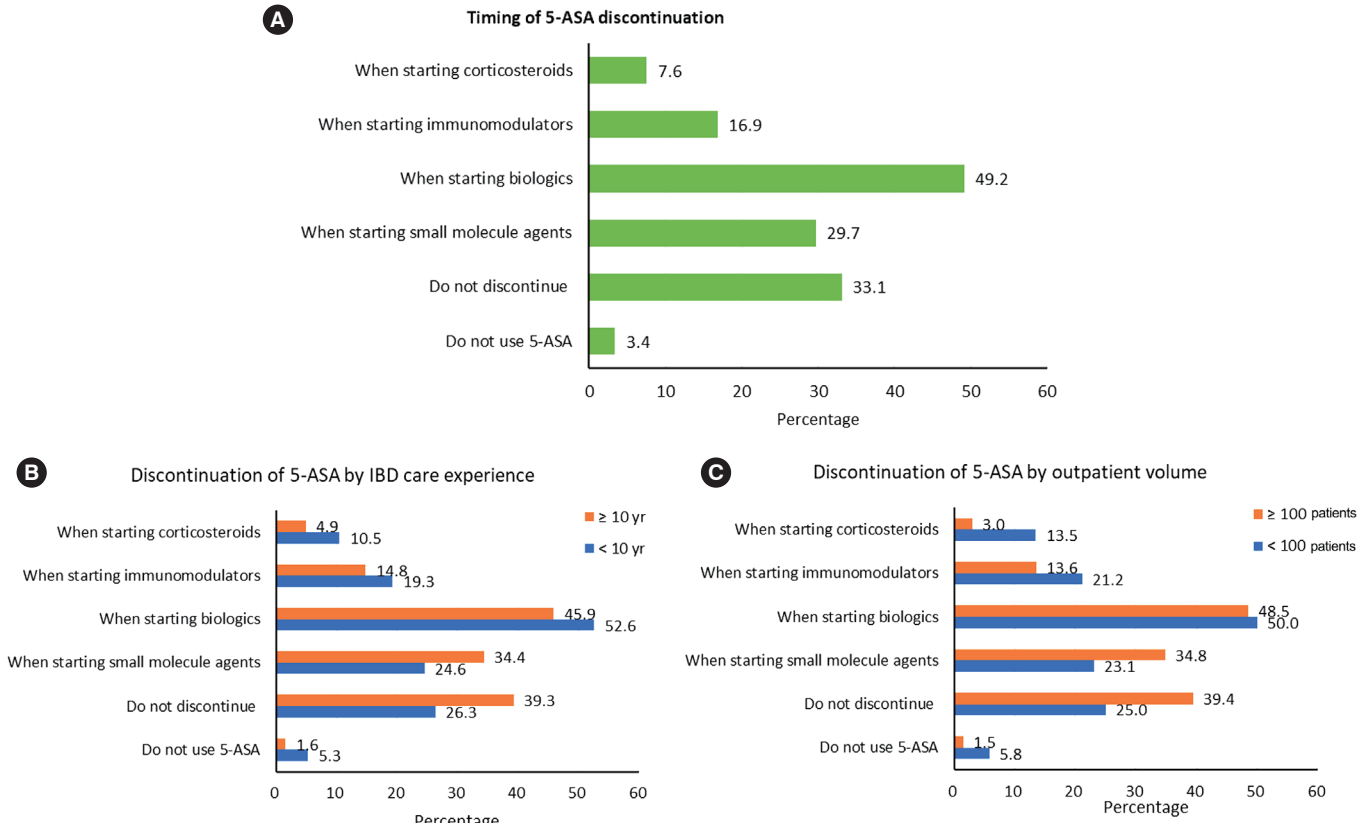

Fig. 4. Patterns of 5-ASA discontinuation in CD. (A) Situations for discontinuing 5-ASA in Crohn's disease. (B) Timing of 5-ASA discontinuation by physician subgroups based on IBD care experience (< 10 years vs. ≥ 10 years). (C) Timing of 5-ASA discontinuation by physician subgroups based on outpatient volume in the past 3 months (< 100 patients vs. ≥ 100 patients). 5-ASA, 5-aminosalicylate; IBD, inflammatory bowel disease.

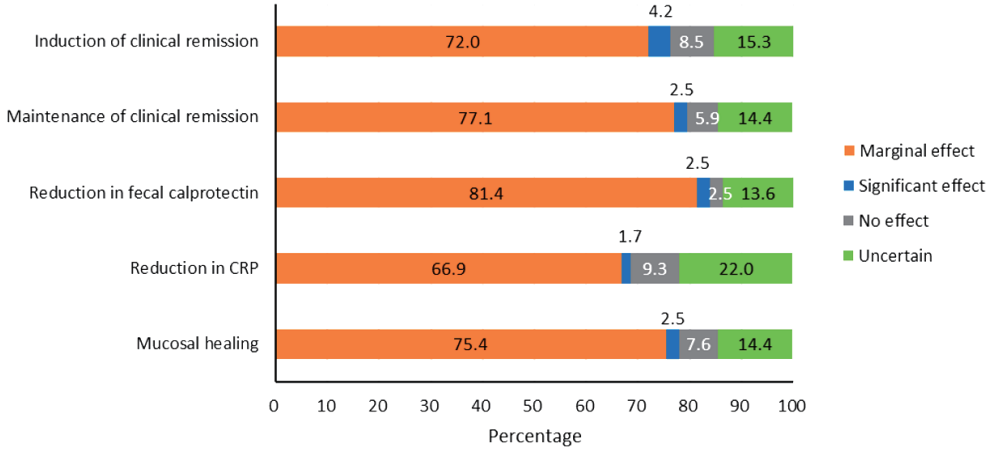

Fig. 5. Perceived effectiveness of 5-aminosalicylate in Crohn's disease. CRP, C-reactive protein.

ment escalation (Fig. 4A). In subgroup analyses, patterns of 5-ASA discontinuation were generally comparable between physicians with < 10 years versus ≥ 10 years of IBD care experience and between those with < 100 IBD outpatients in the past 3 months versus ≥ 100 IBD outpatients in the past 3 months. A considerable proportion of physicians in all subgroups reported continuing 5-ASA when initiating other therapies. The most common reason for discontinuation was initiation of biologic therapy (Fig. 4B and C).

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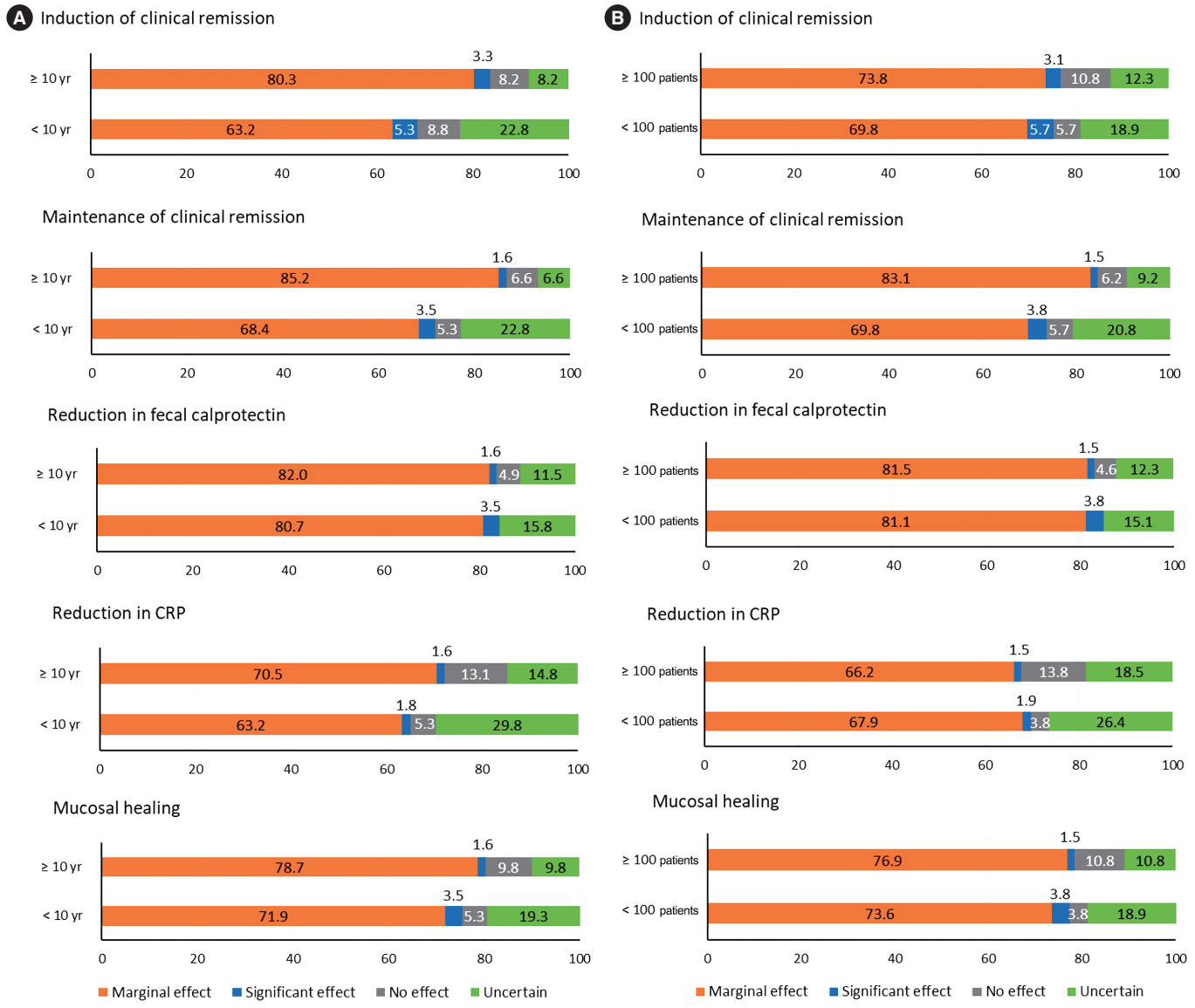

Fig. 6. Perceived effectiveness of 5-aminosalicylate in Crohn's disease by physician subgroup. (A) Subgroups based on inflammatory bowel disease care experience (< 10 years vs. ≥ 10 years). (B) Subgroups based on outpatient volume in the past 3 months (< 100 patients vs. ≥ 100 patients). Each bar shows the distribution of responses regarding the proportion of perceived effectiveness of each treatment goal. CRP, C-reactive protein.

3. Perceptions Regarding the Efficacy of 5-ASA in CD

Physicians' perceptions of the therapeutic efficacy of 5-ASA in CD were generally modest (Fig. 5). Most respondents considered 5-ASA to have a marginal effect across all evaluated treatment goals. Specifically, 72.0% perceived 5-ASA to have a marginal effect in inducing clinical remission, and 77.1% reported similar views regarding maintenance of remission.

Regarding biomarker responses, 81.4% of respondents believed that 5-ASA had a marginal effect in reducing fecal calprotectin levels, and 66.9% reported marginal effect in lowering C-reactive protein (CRP). The perception of 5-ASA as having a significant effect was low across all domains, ranging from 1.7% to 4.2%. A substantial proportion of respondents expressed uncertainty about the effectiveness of 5-ASA, particularly in objective outcomes such as CRP reduction (22.0%) and mucosal healing (14.4%). Notably, 9.3% of physicians considered 5-ASA to have no effect on CRP reduction, and 8.5% reported no effect on clinical remission induction.

Subgroup analyses showed that physicians with ≥10 years of IBD experience were significantly more likely to report a

marginal effect of 5-ASA for both induction (P=0.043) and maintenance (P=0.047) of clinical remission, compared to those with less experience. However, no significant differences were observed between subgroups in perceptions related to biomarker response or mucosal healing (Fig. 6).

DISCUSSION

5-ASA has long been used in the treatment of IBD and remains a commonly prescribed agent among physicians worldwide.[11,12] In this study involving IBD specialists in Korea, we found that approximately 68% of respondents reported prescribing 5-ASA to more than half of their patients with CD in routine clinical practice. Furthermore, the majority of physicians perceived 5-ASA to exert more than a marginal effect on various clinical and biochemical outcomes in CD. Notably, regardless of physicians' clinical experience or IBD outpatient volume, 5-ASA was widely prescribed, and perceptions of its efficacy across various treatment goals did not differ between subgroups.

The evidence regarding the efficacy of 5-ASA in achieving clinical outcomes in CD remains inconsistent. A recent network meta-analysis concluded that high-dose mesalamine was less effective than budesonide but may be considered for patients who prefer to avoid corticosteroids.[13] In contrast, a Cochrane systematic review reported that high-dose mesalamine was not effective in inducing response or remission and yielded inconclusive results when compared with budesonide.[14] Another meta-analysis evaluating the efficacy of 4 g/day mesalamine in active CD showed a statistically significant reduction in CDAI by 63 points in the high-dose mesalamine group, compared to a 45-point reduction in the placebo group (P=0.04).[15] In our study, approximately 40% of respondents reported prescribing a daily dose of 4 g or higher, and most physicians favored standard to high doses of 5-ASA in clinical practice. Regarding maintenance of remission, most existing studies have focused on patients who achieved remission through corticosteroids. In general, these studies found that 5-ASA was not superior to placebo or comparator agents such as immunomodulators or corticosteroids in maintaining remission in patients with CD.[16,17]

The recent Western IBD treatment guidelines have consistently recommended against the use of 5-ASA in CD. The most recent ECCO guidelines strongly recommend against the use of 5-ASA for induction of remission (moderate-quality evidence) as well as for maintenance of remission (low-quality evidence) in CD.[9] Similarly, the AGA guidelines provide a strong recommendation against the use of 5-ASA or sulfasalazine for both induction and maintenance of remission in patients with moderate to severe CD, based on moderate certainty of evidence.[10] In contrast, the most recent Korean guidelines acknowledge the limited efficacy of 5-ASA for both induction and maintenance of remission in mild CD, but still suggest it may be considered due to its favorable safety profile and ease of use.[18] Similarly, the 2023 Taiwan guidelines also support its use in mild CD.[19]

There appears to be a clear gap between guideline recommendations and actual clinical practice regarding the use of 5-ASA in CD. 5-ASA agents have been favored for over three decades, particularly in the management of mild to moderate CD. One study reported that approximately 90% of gastroenterologists prescribe mesalamine as either as monotherapy or in combination for patients with active CD.[20] According to a survey from the Swiss IBD cohort, more than 60% of CD patients were prescribed 5-ASA, and physicians considered the treatment effective in approximately half of the cases, whether administered orally or topically.[21] Furthermore, recent population-based cohort studies have shown that over half of CD patients received 5-ASA at some point during their disease course.[22-24] These findings suggest that a favorable perception of 5-ASA use in CD persists even in Western countries, which is consistent with the results of our study.[12,25]

The discrepancy between guideline recommendations and real-world clinical practice regarding the use of 5-ASA in CD may be attributed to the following factors. With the growing focus on biologics and small molecule agents in recent years, new research on 5-ASA has become scarce. The most recent randomized controlled trial was published over a decade ago. As a result, current guideline recommendations are largely based on relatively outdated evidence. These earlier studies have notable limitations, including heterogeneity in inclusion criteria and review objectives, and a predominant focus on only clinical outcomes. The potential effects of 5-ASA on treatment targets that have recently gained clinical importance, such as biochemical markers and mucosal healing, remain insufficiently investigated.

The widespread and long-standing use of 5-ASA in CD is likely attributable to its favorable safety profile and high treatment persistence.[12,17,20] Compared to other therapeutic agents, 5-ASA is associated with fewer adverse events and lower discontinuation rates due to intolerance. Corticosteroids, in contrast, may lead to complications such as uncontrolled diabe-

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tes, osteoporosis, and hypertension. Biologic agents and immunomodulators also carry the risk of serious adverse events, including opportunistic infections and malignancies.[26] 5-ASA is thought to exert its anti-inflammatory effects by activating peroxisome proliferator-activated receptors in gastrointestinal epithelial cells, which play a role in modulating intestinal inflammation.[27] Rather than being systemically absorbed, 5-ASA primarily acts locally at the site of inflammation in the intestinal mucosa to exert its therapeutic effects.[27] Given its relative safety and the significantly higher risks associated with alternative therapies, even modest efficacy may result in a favorable risk-benefit profile for 5-ASA.

CD is known for its heterogeneous natural course, and a subset of patients may maintain long-term remission with minimal or even no treatment.[28] A population-based cohort study from Europe reported that more than half of patients with CD received 5-ASA at some point during their disease course, and approximately 16% were able to maintain a quiescent disease state with 5-ASA monotherapy alone.[12] As the economic burden of CD continues to rise, therapeutic decisions must balance both efficacy and cost.[29,30] In our study, the majority of respondents perceived 5-ASA to have at least a marginal effect not only on the induction and maintenance of clinical remission, but also on biochemical markers and mucosal healing. In this context, a blanket recommendation to discontinue 5-ASA in all patients with CD should be approached with caution.

In this study, the prescribing pattern of 5-ASA according to disease location showed that more than half of respondents used 5-ASA regardless of disease location, while 57% reported use in patients with colonic or ileocolonic CD. Previous studies have suggested that 5-ASA may be most effective in the terminal ileum and colon.[31] However, data from stratified analyses based on disease location are limited, making it difficult to generalize the efficacy of 5-ASA across all CD phenotypes. The therapeutic effect of 5-ASA may also vary depending on its formulation, with certain preparations targeting specific regions of the small bowel or colon. In our study, most respondents reported using time-dependent release 5-ASA, which may reflect an effort to address the transmural and extensive nature of inflammation in CD.

When prescribing patterns were evaluated by disease activity, approximately half of the physicians reported using 5-ASA irrespective of disease severity. The other half indicated that they primarily prescribed it in cases of non-active or mildly active CD. In previously conducted randomized controlled trials on 5-ASA, the definition of disease activity has varied considerably across studies. Some trials did not impose restrictions on baseline disease activity at enrollment, while others included patients with severe CD. Notably, no randomized trials have specifically targeted patients with mild CD. The lack of stratification of CD by severity in evaluating the efficacy of 5-ASA seems to have further obscured the evidence regarding its effectiveness in CD. A network meta-analysis that performed sensitivity analyses according to baseline disease activity showed that high-dose mesalamine was superior to placebo in trials that limited inclusion to patients with a CDAI score between 150 and 450.[13]

Regarding the timing of 5-ASA discontinuation, 49.2% of respondents indicated that they would consider stopping 5-ASA when initiating biologics, and 29.7% when starting small molecule agents. This likely reflects adherence to current guideline recommendations. However, there is a lack of evidence regarding the optimal timing for 5-ASA withdrawal and the risk of disease relapse after discontinuation.[32] In our subgroup analyses, we observed that a substantial proportion of physicians continued 5-ASA regardless of their clinical experience or IBD outpatient volume, indicating consistent prescribing patterns across subgroups.

This study has several limitations. First, the survey was primarily conducted among physicians affiliated with tertiary hospitals in Korea, which may limit the generalizability of our findings. Nevertheless, the study included respondents with a wide range of ages and varying levels of experience in IBD care. Future research involving a broader range of physicians across Asia or on a global scale could help validate and expand upon these findings, and studies incorporating real-world patient data, comparative effectiveness, cost-effectiveness analyses, and treatment outcomes would further strengthen the evidence base. Second, as the data were self-reported, the possibility of social desirability bias cannot be excluded. Moreover, since the use of advanced therapies is influenced by various national reimbursement policies, respondents' treatment choices may have been affected by such external constraints. Third, as the survey was conducted online, it is prone to response bias, since participants may not always respond truthfully or accurately. In addition, misunderstandings or misinterpretations of survey questions may exist, potentially compromising the accuracy of the responses.

In conclusion, this study demonstrates that physicians involved in IBD care in Korea commonly prescribe 5-ASA for patients with CD in routine clinical practice. Furthermore, the

majority perceive 5-ASA to have more than a marginal effect not only on clinical outcomes but also on biomarkers and mucosal healing. The differences between current clinical practice and existing guideline recommendations appear to stem from various practical factors, including academic perspectives, clinical experience, and the intrinsic properties of the drug. Therefore, careful consideration of these factors should precede any decision to completely exclude 5-ASA from CD management.

ADDITIONAL INFORMATION

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Conflict of Interest

Kim JE and Kim ES are editorial board members of the journal but were not involved in the peer reviewer selection, evaluation, or decision process of this article. No other potential conflicts of interest relevant to this article were reported.

Data Availability Statement

All data, analysis methods, and study materials relevant to the study are included in the article or are available upon request from the corresponding authors, Jung SA and Moon W.

Author Contributions

Conceptualization; Data curation: Bae JH, Shin SY, Moon W, Jung SA. Formal analysis; Investigation; Methodology: Bae JH, Shin SY, Kim DH, Hong SM, Song EM, Kim JE, Yang YJ, Yoon J, Moon W. Supervision: Kang SB, Kim ES, Kim SE, Kim SJ, Lee J, Na SY, Park SJ, Park SH, Moon W, Jung SA. Writing - original draft: Bae JH, Shin SY, Kim DH, Hong SM, Song EM, Kim JE, Yang YJ, Yoon J, Moon W. Writing - review & editing: Bae JH, Shin SY, Kang SB, Kim ES, Kim SE, Kim SJ, Lee J, Na SY, Park SJ, Park SH, Moon W, Jung SA. Approval of final manuscript: all authors.

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Supplementary Material

Supplementary materials are available at the Intestinal Research website (https://www.irjournal.org).

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