Systematic Review and Meta-Analysis

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# The influence of pretreatment with PPI on *Helicobacter pylori* eradication

## A systematic review and meta-analysis

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**Abstract**

**Background:** In this meta-analysis, we aimed to comprehensively investigate the impact of pretreatment with proton pump inhibitor (PPI) on *Helicobacter pylori* (*H. pylori*) eradication and provide novel inspiration to clinical practice.

**Methods:** Relevant studies were selected through PubMed, Embase, and Cochrane Library from inception to March 2021. Two reviewers performed the selection independently. The primary outcome of the meta-analysis was the eradication rate. A modified Jadad scale was used to evaluate literature quality quantitatively.

**Results:** Ten studies were included in this research. The results showed no significant difference between PPI pretreatment and standard treatment on eradication of *H. pylori* [relative risk (RR): 1.17, 95% confidence interval (95% CI): 0.0.73–1.88]. There was no significant difference between the PPI pretreatment group and the standard therapy group for conventional triple therapy, PPI and amoxicillin and clarithromycin (RR: 1.29, 95% CI: 0.60–2.77). Similar results were obtained in the therapy strategy of PPI and amoxicillin and metronidazole (RR: 3.01, 95% CI: 0.62–14.74). Interestingly, for the therapy regimen of PPI and clarithromycin and metronidazole, PPI pretreatment indicated superiority on *H. pylori* eradication rate (RR: 0.48, 95% CI: 0.23–0.97, $P < .05$).

**Conclusion:** PPI pretreatment did not affect the *H. pylori* eradication rates, regardless of the various types of bacteriostatic antibiotic, except the therapy regimen of PPI and clarithromycin and metronidazole.

**Abbreviations:** DU = duodenal ulcer, FD = functional dyspepsia, FEM = fixed-effects model, *H. pylori* = Helicobacter pylori (*H. pylori*), IU = iatrogenic ulcer, NUD = non-ulcer diseases, PPI = proton pump inhibitor, PUD = peptic ulcer disease, REM = random-effects model, RR = relative risk.

**Keywords:** eradication, *Helicobacter pylori*, meta-analysis, PPI

## 1. Introduction

*Helicobacter pylori* (*H. pylori*), a gram-negative bacterium, affects the gastric environment of more than half of the global population. It has been demonstrated that the positive status is associated with generalizable factors such as age, living conditions and socioeconomic status, etc.[1,2] In addition, *H. pylori* is the predominant factor leading to peptic ulcer disease, and worse still. It may contribute to gastric cancer without effective medical intervention.[3–5] As the *H. pylori* eradication advanced, the incidence of non-cardia gastric cancers has dramatically decreased owing to the appealing management with *H. pylori* infection, revealing the essentiality of *H. pylori*-infection management.[6]

Regarding the treatment strategy of *H. pylori* infection, the main treatment objectives are to relieve symptoms and recover the ravaged gastric mucosa by *H. pylori*.[7] Nowadays, the quadruple bismuth therapy of proton pump inhibitor (PPI), clarithromycin, amoxicillin, and bismuth in combination for 10 to 14 days has been widely considered as the first-line regimen for *H. pylori* eradication in most countries.[8] Moreover, additional bismuth to the triple regimen is applied as the quadruple therapy in several areas.[9] However, due to the resistance to clarithromycin or amoxicillin, antibiotics used in the regimen have been changed. For example, clarithromycin can be switched to levofloxacin.[10] Meanwhile, metronidazole and tetracycline are commonly used, especially when there is an allergy to penicillin.[11]

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*The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.*

*All the authors declare that they have no conflicts of interest.*

*The datasets generated during and/or analyzed during the current study are publicly available.*

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The opinion of pretreatment with PPI has been proposed to obtain a higher eradication rate of *H. pylori*. Among patients suffering from peptic ulcers accompanied by bleeding or chronic gastritis, pretreatment of PPI may settle the symptoms and contribute to the following treatment.[12] Moreover, pretreatment of PPI has shown its superiority in preventing the situation of iatrogenic ulcers induced by extensively applied endoscopy in gastric neoplasms.[13,14] Nevertheless, there is no consensus on pretreatment of PPI in *H. pylori* eradication, and the efficacy is needed to be elucidated. Therefore, we conducted this meta-analysis to comprehensively investigate the impact of pretreatment on *H. pylori* eradication and provide novel inspiration to clinical practice. Although only a few studies have investigated this topic, it still includes enough studies and sample sizes for a meta-analysis.

## 2. Method

### 2.1. Study screening

We did a computerized search of relevant studies through PubMed, Embase, and Cochrane Library from inception to March 2021. Index searches included the following MeSH terms: "(helicobacter pylori and *H. pylori*)," " (proton pump inhibitor and PPI)," " (eradica* and cure rate)," " (pre and before)," "(in advance and earlier)." There was no language restriction for this search. All reviews, editorials, commentary, and case reports were excluded. The selected literature was imported in Endnote X9.

### 2.2. Inclusion and exclusion criteria

#### 2.2.1. The inclusion criteria of the studies were.

(1) It was a positive *H. pylori* test, such as (a) rapid urease test by gastric mucosal biopsy from the body at the gastric angularis and greater curvature of the antrum; (b) histological examination by Warthin-Starry silver staining; and (c) 13C-urea breath test.
(2) Interventions: PPI was used before anti-*H. pylori* treatment, and as the initial treatment, and the control group received the same treatment except for the intervention.
(3) Outcome evaluation indicators: After at least 4 weeks of anti-*H. pylori* treatment, PPI and bismuth agents were stopped for at least 2 weeks, and *H. pylori* was tested again; The specific number and eradication situation of each group were reported, respectively.

#### 2.2.2. The exclusion criteria were.

(1) The full text could not be obtained or the literature data was incomplete, and it was unable to contact the author.
(2) Treatment outcomes were not reported in detail.
(3) The literature was a repeated publication.

### 2.3. Data extraction

Two reviewers performed the selection. If the 2 reviewers did not achieve consensus, a third reviewer was asked for the final decision. Literature selection and data extraction of retrieval results were performed via the following three steps. First, Endnote X9 software was used to eliminate all the repeated publications. Second, we excluded the literature that did not achieve the inclusion criteria after reading the titles and abstracts. Third, we extracted the required data after carefully reading through the full texts of the literature.

### 2.4. Outcomes

The essential characteristics of the selected retrieval results were extracted, such as the first author, year of study and publication, and country. The primary outcome of the meta-analysis was the eradication rate. The eradication rate was diagnosed after at least 4 weeks of anti-*H. pylori* treatment. Then, PPI and bismuth agents were stopped for at least 2 weeks. Subsequently, *H. pylori* was tested again and shown negative.

### 2.5. Quality assessment

A modified Jadad scale was used to evaluate literature quality quantitatively.[15] It is a quality evaluation to assess the randomization, blinding, withdraws and dropouts, inclusion and exclusion criteria, adverse complication, and statistical analysis. An 8-item scale was scored from 0 (the poorest) to 7 (the best). The articles with scores between 4 and 7 were indicated as high-quality articles, whereas the articles with scores between 0 and 3 were indicated as poor-quality articles.

### 2.6. Statistical analysis

The meta-analysis was performed through RevMan 5. 2 to conduct data analysis. First of all, the statistical $I^2$ was used to evaluate the heterogeneity among studies. If $I^2 \leq 50\%$, indicating the excellent homogeneity among studies, a fixed-effects model (FEM) was used. If $I^2 > 50\%$, showing the heterogeneity among studies, a random-effects model (REM) was used, and the subgroup analysis would be performed. In addition, the included RCTs were considered as enumeration data, and relative risk (RR) was used as the analysis statistic. Then, the eradication rate was calculated using the Mantel–Haenszel method. Finally, the publication bias was assessed through funnel plots.

## 3. Results

### 3.1. Study selection

After thoroughly searching of PubMed, Embase, and Cochrane Library, 545 records were obtained in total. After excluding the repeated literature, there were 253 studies left. Finally, through routine discussion regarding the inclusion of articles, 10 qualified studies were included in this meta-analysis.[16–25] The whole process of this meta-analysis is displayed in Fig. 1.

### 3.2. Study characteristics

This meta-analysis included 2031 eligible patients, containing 932 patients with PPI pretreatments and 1099 patients without PPI pretreatment. Pathological types of diseases consisted of peptic ulcer disease (PUD), functional dyspepsia (FD), duodenal ulcer (DU), iatrogenic ulcer (IU), and non-ulcer diseases (NUD). Different PPIs were adopted as different pretreatments: Omeprazole, Pantoprazole; Lansoprazole; Rabeprazole; Esomeprazole, and the pretreatment duration varied from 3-day to 8-week. As our objective was to investigate the impact of pretreatment with PPI on *H. pylori*, different studies with different dosages and

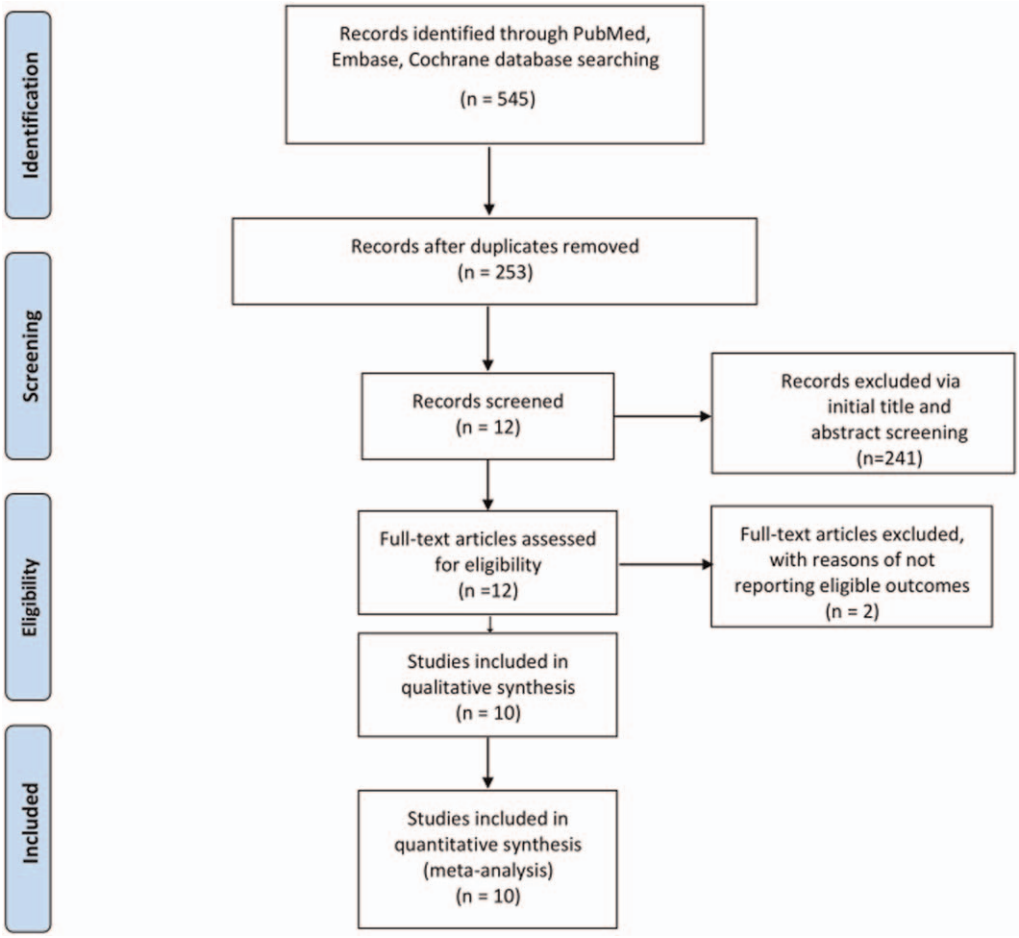


**Figure 1.** Flow diagram of study selection.

duration of PPI were included in this study. Moreover, *H. pylori* eradication regimens from the included studies varied in adopting different antibiotics or PPIs. Except for Inoue et al,[22] the loss of following in included studies was considerable. Detailed information of baseline characteristics in each included study is documented in Table 1.

### 3.3. Quality assessment

Two reviewers independently assessed the risk of bias under routine discussion through the Jadad scale. The mean value was 3.7, the median value was 4, and the range was 2 to 5. A total of 2 articles were rated as 5 out of 7 scores. Only 1 article was rated as 2 out of 7 scores.

**Table 1**

**Baseline characteristics of included studies.**

| Study | Country | Type | Patients (I/C) | Age, yr | | Pre-PPI | HP regimen | LoF | Jadad score |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Intervention | Control | | | | |
| Annibale et al[18] | Italy | PUD | 38/40 | NR | NR | O, 2-week | O+A+M, 2-week | 2.60% | 3 |
| Okada et al[16] | Japan | PUD/FD | 45/45 | 47.3±12.5 | 46.2±13.1 | O, 1-week | O+A+M+Rox,1-week | 2.00% | 3 |
| Adamek et al[17] | German | DU/FD | 52/53 | NR | NR | P, 1-week | P+C+M, 2-week | 2.00% | 4 |
| Calabrese et al[19] | Italy | PUD/FD | 50/50 | 51.3±11.34 | 52.5±14.0 | P, 4-day | P+Azi+Ti, 3-day | 1.00% | 4 |
| Adachi et al[20] | Japan | PUD/FD | 40/40 | NR | NR | O, 5-day | O+A+C, 5-day | 7.50% | 5 |
| Janssen et al[21] | Netherland | PUD/FD | 38/38 | NR | NR | L, 3-day | L+B+Te+M, 2-day | 0 | 5 |
| Inoue et al[22] | Japan | PUD | 57/59 | 50.6±13.0 | 52.2±12.3 | L, GU 8-week, DU 6-week | L+A+C, 1-week | 9.40% | 4 |
| Fan et al[23] | China | DU | 80/80 | 48.5±4.6 | 47.6±4.5 | O, 1week | O+C+F, 1-week | 1.80% | 2 |
| Seung et al[25] | Korea | IU/PUD/NUD | 517/573 | 51.2±13.4 | 51.8±12.2 | L/R/E/O, 3-day | L/E/R+A+C, 7-day | 0 | 3 |
| Shinozaki et al[24] | Japan | GU/DU | 29/142 | 58.1±14.1 | 62.3±17.7 | L/R/E/O, 4-week | A+C+V, 1-week | 0 | 4 |

A = Amoxicillin, Azi = Azithromycin, B = Bismuth citrate, C = Clarithromycin, C = Control, DU = Duodenal ulcer, E = Esomeprazole, FD = Functional dyspepsia, HP = Helicobacter pylori, I = Intervention, IU = Iatrogenic ulcer, L = Lansoprazole, M = Metronidazole, NR = not reported, NUD = Non-ulcer disease, O = Omeprazole, P = Pantoprazole, PUD = Peptic ulcer disease, R = Rabeprazole, Te = tetracycline, Ti = Tinidazole, V = Vonoprazan.

*Values are presented as mean ± sd.

### 3.4. Study results

The overall results indicated no significant difference between PPI pretreatment and standard treatment on eradication of *H. pylori* [10 studies, 2031 participants, RR: 1.17, 95% confidence interval (95% CI): 0.0.73–1.88, $P > .05$]. A REM was used ($I^2 = 64\%$). In addition, the subgroup analysis focusing on different regimens was performed to further assess the underlying factors influencing the results. There was no significant difference between the PPI pretreatment and the standard therapy group for conventional triple therapy, PPI and amoxicillin and clarithromycin (4 studies, 1441 participants, RR: 1.29, 95% CI: 0.60–2.77, $P > .05$). Similar results were obtained in the therapy strategy of PPI and amoxicillin and metronidazole (2 studies, 164 participants, RR: 3.01, 95% CI: 0.62–14.74, $P > .05$). Only Calabrese et al[19] reported the therapy strategy of PPI and azithromycin and tinidazole on *H. pylori* eradication rate, revealing questionable efficacy between the 2 groups (99 participants, RR: 0.98, 95% CI: 0.34–2.83, $P > .05$). Janssen et al[21] reported the therapy regimen of PPI and bismuth, tetracycline, and metronidazole on *H. pylori* eradication rate, indicating no significant difference between the 2 groups (76 participants, RR: 2.17, 95% CI: 0.92–5.10, $P > .05$). Interestingly, for PPI's therapy regimen and clarithromycin and metronidazole, PPI pretreatment indicated superiority on *H. pylori* eradication rate (2 studies, 251 participants, RR: 0.48, 95% CI: 0.23–0.97, $P < .05$). Detailed information of the above-mentioned results is shown in Fig. 2.

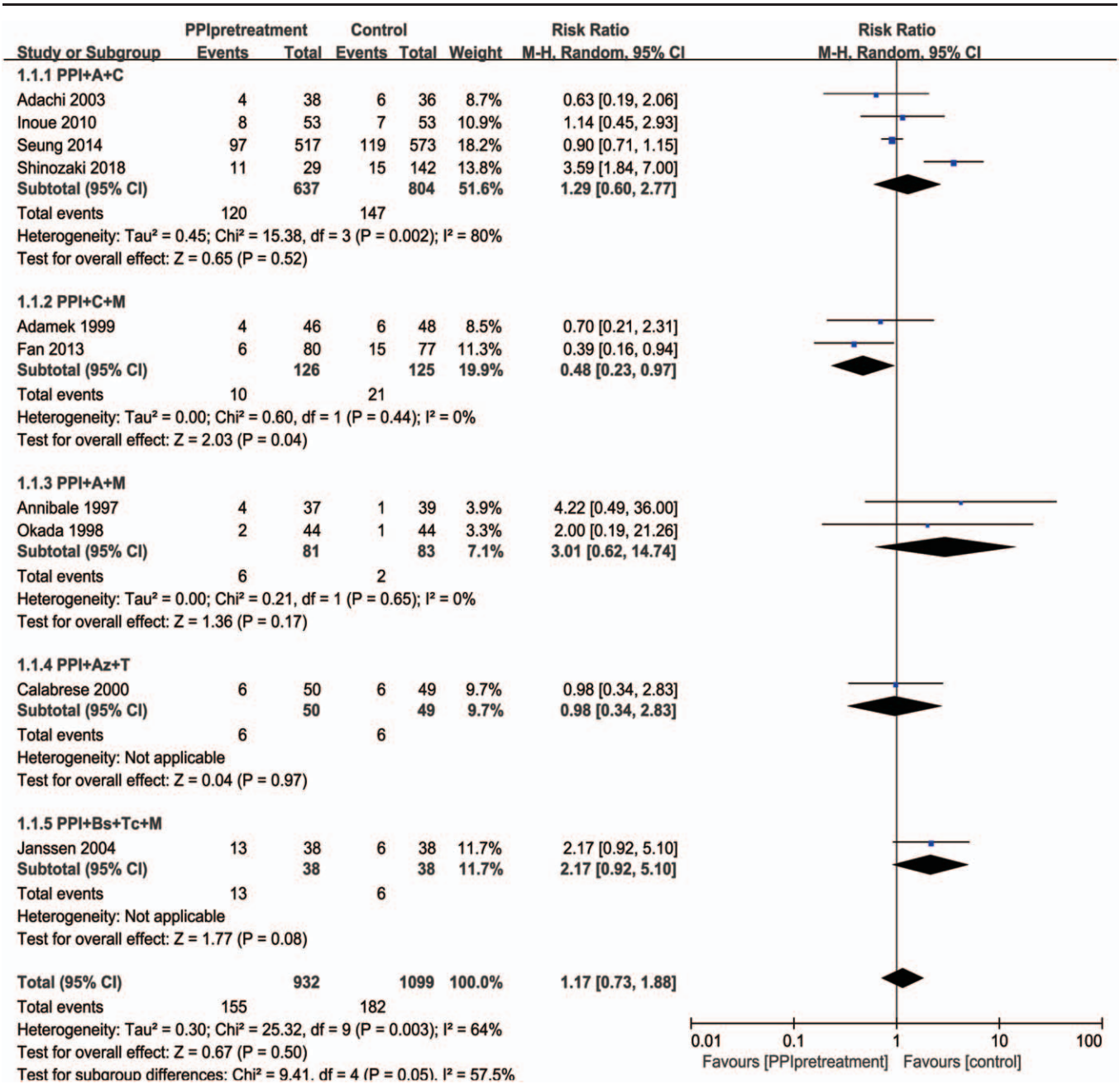


**Figure 2.** The forest plot of the influence of pretreatment with PPI on *Helicobacter pylori* eradication.

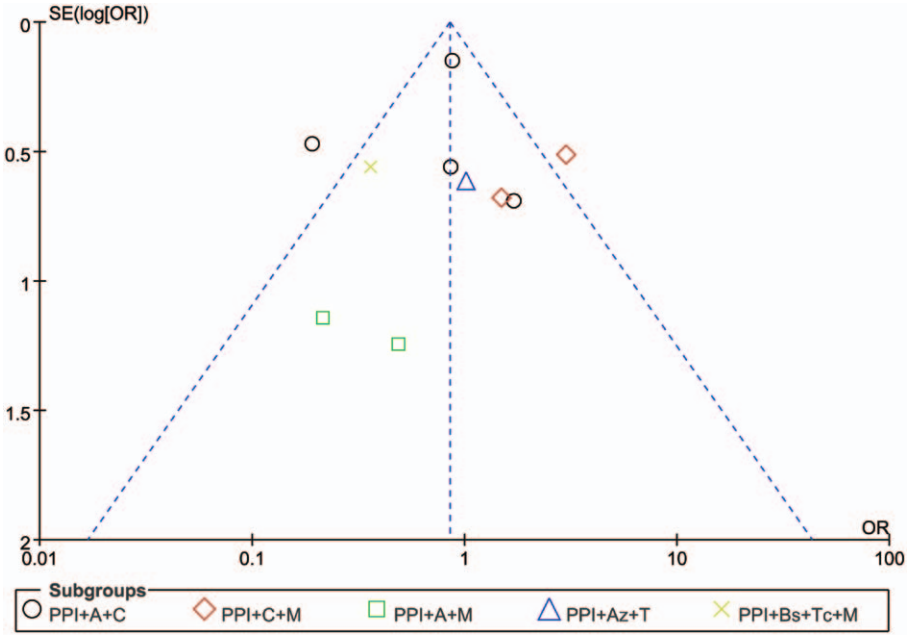


**Figure 3.** The funnel plot of publication bias.

### *3.5. Publication bias assessment*

A symmetrical funnel plot was obtained, indicating no significant publication bias among the included studies. Visualized results of publication bias are shown in Fig. 3. Egger's symmetry test was performed, and the results of $P = .509$ showed no publication bias.

## 4. Discussion

*Helicobacter pylori* is a significant cause of peptic ulcer, gastric cancer, and other diseases. Eradication of *H. pylori* can promote ulcer healing, significantly reduce the ulcer recurrence rate, and benefit some patients with functional dyspepsia.[4,26,27] PPIs are a vital part of the *H. pylori* eradication program, making antibiotics more stable in gastric acid and improving the eradication rate by increasing the PH value of gastric juice.[28] However, some studies have found that PPI alone can induce the sphericity of *H. pylori*,[24] which reduces the sensitivity of *H. pylori* to antibiotics and reduces the eradication rate. Therefore, it is necessary to conduct an updated and level I evidence study. Our updated research with late-appearing data may be different from early-appearing data.[29] It was found that different regimens accompanying PPI provided different outcomes for *H. pylori*-infected patients. Five subgroups were divided and studied. It covered the most common *H. pylori* treatment plans with these subgroups.

Previous studies have indicated that using PPIs as the pretreatment predicts eradication failure.[24] Our results showed that PPI did not affect the eradication rate of *H. pylori*. The possible reason PPI did not become a positive factor was that the antibiotics could not work effectively due to the unideal environment. Clarithromycin and amoxicillin are commonly used as bacteriostatic antibiotics. These medications exert their effect by suppressing bacterial proliferation depending on the proliferative bacteria. However, long-term PPI suppresses the growth of bacteria and the effectiveness of the antibiotics during the treatment.[30,31] Besides, patients commonly suffer from gastric neoplasms, accompanied by a lower gastric acid secretory function. Those theories may contribute to a consistent result of our findings.

The meta-analysis results are closely related to the quality of the included literature. Therefore, we finally retrieved the 10 papers included in the standard of new literature to minimize bias.[32] Furthermore, we added the most updated papers. For example, this meta-analysis included an article containing an 11-multicenter-randomized-controlled study. The literature is comprehensive, with higher quality compared with the previous literature. The funnel plot showed no significant publication bias. In addition, sensitivity analysis indicated that our findings were robust in this meta-analysis.

However, there were still 5 included studies with the Jadad score less than or equal to 3 points, for they did not explicitly describe randomization or blinding methods.[15] The outcome indicators in this paper were all objective indicators, and the blind method had no significant impact on the outcome judgment. Thus, the Jadad score itself had limitations. Also, there was heterogeneity in 34% of the included literature, which indicated heterogeneity even within the allowable range of the Cochrane system. The reasons were related to the type, dose, and course of the pre-administration of PPI and anti-*H. pylori* regimens in each study.

Even though it is an updated meta-analysis, there are still some limitations in this study. We summarized the effectiveness of the pretreatment with PPI on *H. pylori* eradication rates, but the resources, length of follow-up, and medication plan for such studies were inconsistent. On the basis of the eradication program, a subgroup analysis was performed to evaluate the impact of different programs. However, there are still some problems in subgroups, such as inconsistent treatment doses. In addition, high-quality evidence was limited.

In conclusion, PPI pretreatment did not affect the *H. pylori* eradication rates, regardless of various types of bacteriostatic

antibiotic. There are still problems in the subgroups, such as inconsistent treatment doses. Therefore, a standard evaluation is suggested for future studies to conclude an accurate outcome.

## Author contributions

KS, XJK, CMM, LXR: Critical revision of the manuscript; KS, XJK, SFZ, LXR: Substantial contribution to the conception and design of the work, manuscript drafting; KS, CMM, ZYL, SFZ: Acquisition, analysis, and interpretation of the data; KS, XJK, CMM, ZYL: Revising the manuscript critically, final approval of the version to be published. All authors have read and approved the final manuscript.

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**Visualization:** Sheng Kuang, Jinkang Xu.
**Writing – original draft:** Sheng Kuang, Jinkang Xu, Miaomiao Chen, Fangzhen Shi.
**Writing – review & editing:** Sheng Kuang, Fangzhen Shi, Xirong Lu.

## References


[1] Alzahrani S, Lina TT, Gonzalez J, et al. Effect of Helicobacter pylori on gastric epithelial cells. World J Gastroenterol 2014;20:12767–80.
[2] Peleteiro B, Bastos A, Ferro A, Lunet N. Prevalence of Helicobacter pylori infection worldwide: a systematic review of studies with national coverage. Dig Dis Sci 2014;59:1698–709.
[3] Malfertheiner P, Megraud F, O'Morain CA, et al. Management of Helicobacter pylori infection–the Maastricht IV/Florence Consensus Report. Gut 2012;61:646–64.
[4] Li WQ, Ma JL, Zhang L, et al. Effects of Helicobacter pylori treatment on gastric cancer incidence and mortality in subgroups. J Natl Cancer Inst 2014;106:766–76.
[5] Ford AC, Gurusamy KS, Delaney B, et al. Eradication therapy for peptic ulcer disease in Helicobacter pylori-positive people. Cochrane Database Syst Rev 2016;4:Cd003840.
[6] Rawla P, Barsouk A. Epidemiology of gastric cancer: global trends, risk factors and prevention. Prz Gastroenterol 2019;14:26–38.
[7] Safavi M, Sabourian R, Foroumadi A. Treatment of Helicobacter pylori infection: current and future insights. World J Clin Cases 2016;4:5–19.
[8] Poonyam P, Chotivitayatarakorn P, Vilaichone RK. High effective of 14-day high-dose PPI- Bismuth-containing quadruple therapy with probiotics supplement for Helicobacter Pylori eradication: a double blinded-randomized placebo-controlled study. Asian Pac J Cancer Prev 2019;20:2859–64.
[9] Malfertheiner P, Mégraud F, O'Morain C, et al. Current European concepts in the management of Helicobacter pylori infection–the Maastricht Consensus Report. The European Helicobacter Pylori Study Group (EHPSG). Eur J Gastroenterol Hepatol 1997;9:1–2.
[10] Chey WD, Leontiadis GI, Howden CW, Moss SF. ACG clinical guideline: treatment of Helicobacter pylori infection. Am J Gastroenterol 2017;112:212–39.
[11] Nyssen OP, Pérez-Aisa Á, Tepes B, et al. Helicobacter pylori first-line and rescue treatments in patients allergic to penicillin: experience from the European Registry on H pylori management (Hp-EuReg). Helicobacter 2020;25:e12686.
[12] Tokoro C, Inamori M, Koide T, et al. Does pretreatment with proton pump inhibitors influence the eradication rate of Helicobacter pylori? Hepatogastroenterology 2010;57:1645–9.
[13] Uedo N, Takeuchi Y, Yamada T, et al. Effect of a proton pump inhibitor or an H2-receptor antagonist on prevention of bleeding from ulcer after endoscopic submucosal dissection of early gastric cancer: a prospective randomized controlled trial. Am J Gastroenterol 2007;102:1610–6.
[14] Yang Z, Wu Q, Liu Z, et al. Proton pump inhibitors versus histamine-2-receptor antagonists for the management of iatrogenic gastric ulcer after endoscopic mucosal resection or endoscopic submucosal dissection: a meta-analysis of randomized trials. Digestion 2011;84:315–20.
[15] Higgins JP, Altman DG, Gøtzsche PC, et al. The Cochrane Collaboration's tool for assessing risk of bias in randomised trials. BMJ 2011;343:d5928.
[16] Okada M, Oki K, Shirotani T, et al. A new quadruple therapy for the eradication of Helicobacter pylori. Effect of pretreatment with omeprazole on the cure rate. J Gastroenterol 1998;33:640–5.
[17] Adamek RJ, Szymanski C, Pfaffenbach B. Pantoprazole suppresses Helicobacter pylori without affecting cure. Helicobacter 1999;4:266–71.
[18] Annibale B, D'Ambra G, Luzzi I, et al. Does pretreatment with omeprazole decrease the chance of eradication of Helicobacter pylori in peptic ulcer patients? Am J Gastroenterol 1997;92:790–4.
[19] Calabrese C, Di Febo G, Areni A, et al. Pantoprazole, azithromycin and tinidazole: short duration triple therapy for eradication of Helicobacter pylori infection. Aliment Pharmacol Ther 2000;14:1613–7.
[20] Adachi K, Hashimoto T, Ishihara S, et al. Comparison of five-day Helicobacter pylori eradication regimens: rabeprazole-based and omeprazole-based regimens with and without omeprazole pretreatment. Curr Ther Res Clin Exp 2003;64:412–21.
[21] Janssen MJ, Laheij RJ, Jansen JB, de Boer WA. The influence of pretreatment on cure rates of Helicobacter pylori eradication. Neth J Med 2004;62:192–6.
[22] Inoue M, Okada H, Hori S, et al. Does pretreatment with lansoprazole influence Helicobacter pylori eradication rate and quality of life? Digestion 2010;81:218–22.
[23] Fan HY, Wang J, Yan GC, et al. Increasing gastric juice pH level prior to anti-Helicobacter pylori therapy may be beneficial to the healing of duodenal ulcers. Exp Ther Med 2013;5:912–6.
[24] Shinozaki S, Osawa H, Sakamoto H, et al. Pre-treatment with proton pump inhibitors decreases the success of primary Helicobacter pylori eradication using a vonoprazan-based regimen. Kaohsiung J Med Sci 2018;34:456–60.
[25] Yoon SB, Park JM, Lee JY, et al. Long-term pretreatment with proton pump inhibitor and Helicobacter pylori eradication rates. World J Gastroenterol 2014;20:1061–6.
[26] Fukase K, Kato M, Kikuchi S, et al. Effect of eradication of Helicobacter pylori on incidence of metachronous gastric carcinoma after endoscopic resection of early gastric cancer: an open-label, randomised controlled trial. Lancet 2008;372:392–7.
[27] Ford A, Delaney B, Forman D, Moayyedi P. Eradication therapy for peptic ulcer disease in Helicobacter pylori positive patients. Cochrane Database Syst Rev 2004;Cd003840.
[28] Ke H, Li J, Lu B, et al. The appropriate cutoff gastric pH value for Helicobacter pylori eradication with bismuth-based quadruple therapy. Helicobacter 2021;26:e12768.
[29] Colditz GA. Overview of the epidemiology methods and applications: strengths and limitations of observational study designs. Crit Rev Food Sci Nutr 2010;50(Suppl 1):10–2.
[30] Nakao M, Malfertheiner P. Growth inhibitory and bactericidal activities of lansoprazole compared with those of omeprazole and pantoprazole against Helicobacter pylori. Helicobacter 1998;3:21–7.
[31] Iwahi T, Satoh H, Nakao M, et al. Lansoprazole, a novel benzimidazole proton pump inhibitor, and its related compounds have selective activity against Helicobacter pylori. Antimicrob Agents Chemother 1991;35:490–6.
[32] Janssen MJR, Laheij RJF, de Boer WA, Jansen JBMJ. Meta-analysis: the influence of pretreatment with a proton pump inhibitor on Helicobacter pylori eradication. Aliment Pharmacol Ther 2005;21:341–5.