Journal of Health and Nutrition Research
Vol. 5, No. 2, 2026, pg. 864-871, https://doi.org/10.56303/jhnresearch.v5i2.1124
Journal homepage: https://journalmpci.com/index.php/jhnr/index

e-ISSN: **2829-9760**

Comparative Diagnostic Performance of Monoclonal Antibody Immunohistochemistry and Modified Giemsa Staining for Helicobacter pylori Detection in Chronic Gastritis

Amalia[1*], Upik A. Miskad[1], Zaldi[1], Gina Andyka Hutasoit[2], Muhammad Aslam[3]

[1] Department of Anatomical Pathology, Faculty of Medicine, Hasanuddin University, Makassar, Indonesia
[2] Department of Anatomical Pathology, Faculty of Medicine, Tadulako University, Palu, Indonesia
[3] Anatomical Pathology Installation, Dr Wahidin Sudirohusodo General Hospital, Makassar, Indonesia

Corresponding Author Email: meimell8076@gmail.com

ORIGINAL ARTICLES

Submitted: 03 December 2025

Accepted: 04 March 2026

Published: 01 August 2026

Keywords:
Chronic gastritis; Helicobacter pylori; Immunohistochemistry; Modified Giemsa; Diagnostic accuracy; Stepwise approach.

ABSTRACT

Accurate detection of *Helicobacter pylori* is essential for the effective management of chronic gastritis. While Modified Giemsa (MG) staining is a common diagnostic tool, its sensitivity can be limited in cases with low bacterial density or atypical morphology, often leading to under-detection. This study aimed to evaluate the comparative diagnostic performance and bacterial density grading of monoclonal antibody immunohistochemistry (IHC) versus MG staining to establish a more precise diagnostic algorithm. This analytical observational study utilized a retrospective cross-sectional design, analyzing 100 gastric biopsy specimens from patients with chronic gastritis. Detection rates and bacterial density, graded according to the Updated Sydney System, were compared between MG and IHC using monoclonal anti-*H. pylori* antibodies. Monoclonal antibody IHC demonstrated a significantly higher detection rate (72%) compared to MG (65%; p = 0.016). Discordance analysis identified seven cases that were positive by IHC but missed by MG, typically representing low-density infections. Although overall inter-method agreement was "almost perfect" (Cohen's kappa = 0.839), IHC staining resulted in a significant ordinal shift toward higher bacterial density grades compared to MG (p = 0.016), providing more accurate staging of the infection. Monoclonal antibody IHC is superior to Modified Giemsa for the detection of *H. pylori*, particularly in identifying cases with low bacterial density or compromised morphology. While MG remains a cost-effective primary screening tool, a stepwise approach is recommended: IHC should be prioritized as a mandatory confirmatory test when histological or clinical suspicion remains high despite a negative MG result.

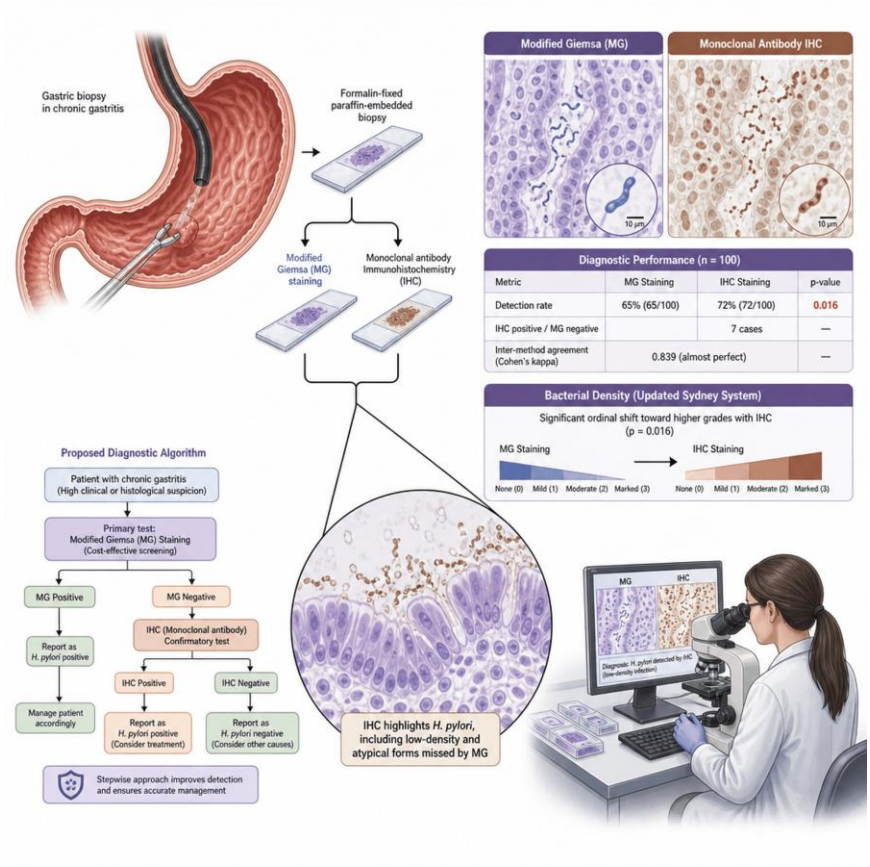
Key Messages:

- IHC is recommended as a supplementary examination in cases where MG is negative, but histological or clinical suspicion remains high. This stepwise approach minimizes under-detection and ensures patients receive appropriate eradication therapy.

Access this article online

Quick Response Code

GRAPHICAL ABSTRACT



INTRODUCTION

Gastritis is inflammation of the gastric mucosa and has several causes, including nonsteroidal anti-inflammatory drugs (NSAIDs), chronic alcohol use, physiological stress, and *Helicobacter pylori* infection (1,2). *H. pylori* is the main pathogen behind chronic gastritis, peptic ulcer, and gastric cancer (3). Diagnosis, however, is not always straightforward. Modified Giemsa (MG) staining is a common histochemical method (4), but its yield drops when bacterial density is low or when the organism takes on an atypical form such as the coccoid variant, situations often linked to partial treatment or long-term proton pump inhibitor (PPI) use (5).

The Updated Sydney System offers a standardized way to grade gastritis severity (6). Its use differs by setting: at endoscopy it scores macroscopic signs such as erythema and edema, while in histopathology it grades bacterial density and mucosal inflammation on a reproducible scale that can guide treatment. The reliability of that grade depends heavily on how well the staining method shows the bacteria. Monoclonal antibody immunohistochemistry (IHC) offers a more specific and sensitive alternative to conventional stains. Rather than relying on morphology and color contrast, IHC targets bacterial antigens such as flagellin, a protein needed for *H. pylori* motility and colonization (7). Because it binds these antigens directly, IHC can detect the organism even when its shape is altered or when colonies are sparse and patchy, and it produces fewer false positives from background mucus or artifacts that often complicate Modified Giemsa interpretation. Because gastritis is common and eradication therapy must be targeted, the diagnostic workflow itself deserves scrutiny. Modified Giemsa is simple and inexpensive, but it can miss low-density infections and, in turn, lead to inadequate management. A direct comparison of the two methods is therefore useful for building a more accurate diagnostic algorithm.

This study set out to measure the correlation and diagnostic performance of monoclonal antibody IHC against Modified Giemsa staining in patients with chronic gastritis. Using the Updated Sydney System for density grading, we examined how the two methods might be combined to improve care at Dr. Wahidin Sudirohusodo Central General Hospital, Makassar, over the 2023-2024 period.

https://doi.org/10.56303/jhnresearch.v5i2.1124

METHODS

Study Design and Patient Selection

This research was conducted as an analytical observational study utilizing a retrospective cross-sectional design. The study population comprised 100 archival paraffin-embedded gastric biopsy blocks from patients diagnosed with chronic gastritis at the Department of Anatomical Pathology, Dr. Wahidin Sudirohusodo Central General Hospital, Makassar, between January 2023 and December 2024. Inclusion criteria consisted of all gastric biopsy samples (antrum, angulus, or corpus) with a confirmed histological diagnosis of chronic gastritis, regardless of initial *H. pylori* status. Samples with insufficient tissue for multiple recuts or poor fixative quality were excluded to ensure diagnostic reliability.

Histopathological Procedures and Staining Protocols

Serial sections of 4 μm thickness were obtained from each paraffin block.

Modified Giemsa Staining

This special histochemical stain was performed to identify the organism based on morphology and color contrast. *H. pylori* was identified as blue-stained helical or curved bacilli located within the gastric pits or the overlying mucus layer.

Monoclonal Antibody Immunohistochemistry (IHC)

IHC was performed using a monoclonal antibody specifically targeting *H. pylori* surface antigens, such as flagellin. The presence of the pathogen was confirmed by the visualization of distinct brown-stained bacterial colonies, resulting from a chromogenic enzymatic reaction. This method was utilized to enhance detection in cases with compromised morphology or low bacterial density.

Evaluation and Grading Criteria

The slides were evaluated using a light microscope under oil immersion (1000x magnification). To ensure objectivity and minimize bias, the evaluation was performed by two independent anatomical pathologists who were blinded to each other's findings and the results of the alternate staining method. Bacterial density was quantified according to the Updated Sydney System on an ordinal scale (0–3):

- Grade 0 (Absent): No bacteria identified.
- Grade 1 (Mild): Sparse bacteria covering less than one-third of the mucosal surface.
- Grade 2 (Moderate): Intermediate numbers of bacteria.
- Grade 3 (Marked): Large clusters or continuous layers of bacteria covering the mucosal surface.

Statistical Analysis

Data were analyzed using SPSS version 29.0. The McNemar test was employed to compare the nominal detection rates (positive vs. negative) between Modified Giemsa and IHC. The Wilcoxon signed-rank test was utilized to analyze differences in the ordinal bacterial density grades between the two methods. Inter-method agreement was assessed using Cohen's Kappa (κ), with values interpreted as follows: 0.61–0.80 (substantial) and 0.81–1.00 (almost perfect). A p-value < 0.05 was considered statistically significant.

RESULTS

General Characteristics of the Samples

Table 1 summarizes the demographic and clinical characteristics of the 100 samples, along with the diagnostic results of both stains. Median age was 50.50 years, and most patients were male (n=61). Biopsy specimens were most often medium-sized tissues (57.0%) and came mainly from the combined "Antrum, angulus" site (43.0%) or "Antrum, angulus, corpus" (29.0%). The two stains performed differently. The monoclonal antibody assay detected more positive cases (72.0%) than Modified Giemsa (65.0%), and it also shifted density grading upward. Where Modified Giemsa placed most positive cases at Grade 1/Mild (48.0%), the antibody method assigned more cases to higher grades, 44.0% at Grade

https://doi.org/10.56303/jhnresearch.v5i2.1124

2/Moderate and 22.0% at Grade 3/Marked. This points to greater IHC sensitivity for the heavier bacterial loads that conventional staining tends to underrepresent.

Table 1. General Characteristics of the Samples (n=100)

Characteristics	n	%
Age		
> 50 years	51	51.0
< 50 years	49	49.0
Median age: 50.50 years (≈50 years)	50.50 (50 years)	
Minimum age: 10.40 years (≈10 years)	10.40 (10 years)	
Maximum age: 82.18 years (≈82 years)	82.18 (82 years)	
Sex		
Male	61	61.0
Female	39	49.0
Biopsi Size		
Small tissue	43	43.0
Medium tissue	57	57.0
Biopsy Location		
Angulus	1	1.0
Antrum	4	4.0
Antrum, corpus	19	19.0
Antrum, angulus	43	43.0
Antrum, angulus, corpus	29	29.0
Antrum, cardia	1	1.0
Corpus	3	3.0
***Helicobacter pylori* Detection**		
Modified-Giemsa		
Positive bacteria	65	65.0
Negative bacteria	35	35.0
Monoklonal antibodi Helicobacter Pylori		
Positive bacteria	72	72.0
Negative bacteria	28	28.0
***Helicobacter pylori* Density Grading (Updated Sydney System)**		
Modified-Giemsa		
Grade 0 (Absent)	35	35.0
Grade 1 (Mild)	48	48.0
Grade 2 (Moderate)	15	15.0
Grade 3 (Marked)	2	2.0
Monoclonal Antibody Helicobacter pylori		
Grade 0 (Absent)	28	28.0
Grade 1 (Mild)	7	7. 0
Grade 2 (Moderate)	44	44.0
Grade 3 (Marked)	22	22.0

Table 2. General Characteristics of *Helicobacter pylori* Detection Using Modified Giemsa Special Histochemical Stain and Monoclonal Antibody *Helicobacter pylori*, Based on Biopsy Location

H. pylori Detection Method			Location							Total
			Angulus	Antrum	Antrum, angulus	Antrum, angulus, corpus	Antrum, cardia	Antrum, corpus	Corpus	
Modified-Giemsa	+	n	1	4	38	12	1	9	0	65
		%	100.0	100.0	88.4	41.4	100.0	47.4	0.0	65.0
	-	n	0	0	5	17	0	10	3	35
		%	0.0	0.0	11.6	58.6	0.0	52.6	100.0	35.0
Total		n	1	4	43	29	1	19	3	100
		%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Monoclonal antibody HP	+	n	1	4	40	15	1	10	1	72
		%	100.0	100.0	93.0	51.7	100.0	52.6.0	33.3	72.0
	-	n	0	0	3	14	0	9	2	28
		%	0.0	0.0	7.0	48.3	0.0	47.4	77.7	28.0
Total		n	1	4	43	29	1	19	3	100
		%	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

https://doi.org/10.56303/jhnresearch.v5i2.1124

Table 2 compares *H. pylori* detection by Modified Giemsa and monoclonal antibody IHC across biopsy sites. Across the 100 cases, IHC identified the organism in 72.0% (n=72) versus 65.0% (n=65) for Giemsa. The gap held at the main sites: in the combined "Antrum, angulus" location (n=43), IHC was positive in 93.0% versus 88.4% for Giemsa, and in the wider "Antrum, angulus, corpus" biopsies (n=29), 51.7% versus 41.4%. IHC was therefore the more sensitive method regardless of where the tissue was sampled.

Comparison of Helicobacter Pylori Detection Between Modified Giemsa and Helicobacter Pylori Monoclonal Antibody

Table 3 cross-tabulates the two methods across the 100 specimens. They agreed on most cases, jointly scoring 65 positive and 28 negative. The disagreements were one-sided: IHC found *H. pylori* in 7 cases that Giemsa had called negative, while no case was Giemsa-positive and antibody-negative. This difference reached significance on the McNemar test (p=0.016), showing that the extra detections came from IHC rather than from chance. At the same time, Cohen's Kappa was 0.839, an "almost perfect" level of agreement by the criteria used. The two stains thus track each other closely overall, even though IHC picks up infections that Giemsa misses.

Table 3. Comparison of the detection of the presence and absence of H. pylori between Modified Giemsa histochemical special staining with Helicobacter Pylori Monoclonal Antibody (n=100) McNemar Test and Cohen's Kappa Test.

***H. pylori* Detection**		**Antibody Monoclonal Helicobacter Pylori**		**Total**	**P-value**	
		Positive bacteria	**Negative bacteria**			
Modified-Giemsa	Positive bacteria	65	0	65	*0.016	**0.839
	Negative bacteria	7	28	35		
	Total	72	28	100		

*Uji *McNemar,* statistically significant if the *p*-value is less than 0.05.
**Uji *Cohen's Kappa,* statistically significant if the *p*-value is more than 0.01. : ≤0 (poor), 0,01–0,20 (slight), 0,21–0,40 (fair), 0,41–0,60 (moderate), 0,61–0,80 (substantial), 0,81–1,00 (almost perfect).

Table 4 compares detection rates by the Wilcoxon test. IHC was positive in 72.0% (n=72) of samples against 65.0% (n=65) for Giemsa, so the share of negative cases was lower with IHC (28.0%) than with Giemsa (35.0%). The Wilcoxon test gave p=0.016, below the 0.05 threshold, confirming a real difference between the two methods and again favoring IHC.

Table 4. Comparison of *H. pylori* Detection Using Modified Giemsa Histochemical Staining and Monoclonal Antibody Assay (*n* = 100) Based on the Wilcoxon Test

***H. pylori* Detection**	**Modified-Giemsa**		**Monoclonal Antibody HP**		**P-value**
	n	**%**	**n**	**%**	
Positive bacteria	65	65.0	72	(72,0%)	
Negative bacteria	35	35.0	28	(28,0%)	*0.016

Wilcoxon Test,* statistically significant if the *p*-value is less than 0.05.

DISCUSSION

The demographic profile of the 100 patients helps frame these results. Patients over 50 formed the largest group (51.0%), consistent with global patterns of *H. pylori* infection (8-10), usually explained by a birth-cohort effect in which infection is acquired in childhood and persists for decades under historically poorer sanitation (8,10). The male majority (61.0%) more likely reflects local factors such as occupational exposure and smoking than any biological difference in susceptibility (11).

Comparative Detection Rates and Local Context

In our data, monoclonal antibody IHC detected *H. pylori* more often than Modified Giemsa (72.0% vs 65.0%, p=0.016). This is a higher yield than some earlier local reports; Sandhika (2019) (12) described

https://doi.org/10.56303/jhnresearch.v5i2.1124

comparable detection in Surabaya, and our results at Dr. Wahidin Sudirohusodo Hospital add to the picture that IHC recovers positive cases MG can miss. The gain comes largely from the specificity of monoclonal antibodies, which bind surface antigens such as flagellin and give a clearer signal than histochemical stains (5,13,14).

Contextualizing the Ordinal Shift in Bacterial Density

A second key result is the upward shift in density grading with IHC (p=0.016). MG classified most positive cases as Grade 1/Mild (48.0%), whereas IHC read a heavier load, 44.0% at Grade 2/Moderate and 22.0% at Grade 3/Marked. Because IHC binds specific antigens such as flagellin, it can reveal bacteria hidden in the mucus layer or those with too little color contrast for MG to catch. That sensitivity matters most for low-density or morphologically altered infections (5,13,14). Grading accurately under the Updated Sydney System is important, since underestimating density misrepresents how severe the infection really is and can steer treatment the wrong way (15).

Morphological Shifts: Coccoid Forms and PPI Use

MG also loses sensitivity when *H. pylori* shifts from its usual helical shape to a coccoid form (5,13), a survival response often triggered by atrophic mucosa or long-term PPI use (5). Since MG depends on recognizing the classic helix, coccoid variants are easily missed or mistaken for debris. IHC binds surface antigens regardless of shape, so it still identifies these cases (13,14).

Biopsy Location and the Impact of "Patchy" Distribution

Results across biopsy sites (Table 2) also point to the patchy distribution of *H. pylori* (16). In multisite biopsies of the antrum, angulus, and corpus, IHC stayed ahead of MG (51.7% vs 41.4%). This supports using IHC to counter sampling error, where sparse or unevenly spread bacteria are easier to see against the gastric background with the high-contrast brown stain (5).

A Stepwise Diagnostic Algorithm

From these findings we suggest a simple two-step diagnostic approach for routine practice:

1. First, use Modified Giemsa for screening. It is cheap and technically simple, which keeps it the sensible starting point (17).
2. Second, confirm with monoclonal IHC when MG is negative but the histology still shows active gastritis (neutrophilic infiltration), or when clinical suspicion stays high (17,18). This keeps high-risk cases from slipping through and links low-cost screening to a more precise confirmatory test (17,19).

Study Limitations

The study has limits. Its design is retrospective and cross-sectional, based on archival paraffin blocks. Medication history, in particular recent PPI or antibiotic use before biopsy, was not consistently recorded. Since these can lower bacterial density or change morphology, they may have affected the results.

CONCLUSION

The main result is that monoclonal antibody IHC detects *H. pylori* in chronic gastritis biopsies more reliably than Modified Giemsa. IHC gave a higher detection rate (72% vs 65%) and shifted density grading upward under the Updated Sydney System. This matters most for infections with low bacterial density or atypical coccoid forms, which standard histochemical staining often misses. On this basis, we suggest a stepwise approach for practice: keep Modified Giemsa as a low-cost first screen, and use monoclonal IHC to confirm high-risk cases. These include a negative MG stain alongside histological signs of active gastritis, or a history of PPI use that may have distorted bacterial morphology. Used this way, the two methods together reduce missed infections and give patients more accurate staging and appropriate eradication therapy.

https://doi.org/10.56303/jhnresearch.v5i2.1124

DECLARATION OF THE USE OF AI

The authors declare that no artificial intelligence (AI), AI-assisted technologies, or large language models (LLMs) were used in the conception of the study, data analysis, or the drafting, writing, and editing of this manuscript. The only exception is the graphical abstract, which was created using the design platform Illustrae (https://illustrae.co/). The authors take full responsibility for the content and accuracy of the graphical abstract and the entire manuscript

FUNDING

This research was funded by Hasanuddin University

ACKNOWLEDGMENTS

The authors would like to express their sincere gratitude to Universitas Hasanuddin for providing the financial support for this research. We also extend our appreciation to the Director of Dr. Wahidin Sudirohusodo Central General Hospital, Makassar, and the staff of the Anatomical Pathology Installation for their permission and assistance in facilitating the data collection process.

CONFLICTS OF INTEREST

The authors declare no conflict of interest

REFERENCES

1. Azer SA, Awosika AO, Akhondi H. Gastritis. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 [cited 2026 Feb 24]. Available from: http://www.ncbi.nlm.nih.gov/books/NBK544250/ PubMed PMID: 31334970.
2. Rakhmani AN, Novita KD, Adani SF. Lifestyle-Associated Acute Gastritis in a Young Adult : A Family Medicine Perspective on Holistic Management. Jurnal Ilmu Kedokteran Keluarga. 2025 Jun 30;4(1):7–12. doi:10.56674/altera.v4i1.41
3. Reyes VE. Helicobacter pylori and Its Role in Gastric Cancer. Microorganisms. 2023 May 17;11(5):1312. doi:10.3390/microorganisms11051312 PubMed PMID: 37317287; PubMed Central PMCID: PMC10220541.
4. Sun Q, Yuan C, Zhou S, Lu J, Zeng M, Cai X, et al. Helicobacter pylori infection: a dynamic process from diagnosis to treatment. Front Cell Infect Microbiol. 2023 Oct 19;13. doi:10.3389/fcimb.2023.1257817
5. Loharamtaweethong K, Puripat N. Comparison of Immunohistochemistry and Conventional Stains for Helicobacter Pylori Detection in Gastric Biopsies of Patients Receiving Proton Pump Inhibitors. Journal of Health Science and Medical Research. 2020 Jul 3;38(4):321–30. doi:10.31584/jhsmr.2020752
6. Nurdin W, Krisnuhoni E. Perbandingan Assessment Gastritis Kronik Berdasarkan Updated Sydney System dan OLGA, OLGYM System di Departemen Patologi Anatomik FKUI/RSCM Tahun 2012. Pratista Patologi. 2016 Jan 4;5(1):74–81.
7. Kumar R, Tachiyama S, Yu H, Heydari S, Guo J, Botting JM, et al. Assembly and glycosylation of Helicobacter pylori sheathed flagella. PNAS Nexus. 2026 Feb 1;5(2):pgag011. doi:10.1093/pnasnexus/pgag011
8. Den Hoed CM, Vila AJ, Holster IL, Perez-Perez GI, Blaser MJ, De Jongste JC, et al. Helicobacter Pylori and the Birth Cohort Effect: Evidence for Stabilized Colonization Rates in Childhood: Stabilization of H. pylori in Children. Helicobacter. 2011 Oct;16(5):405–9. doi:10.1111/j.1523-5378.2011.00854.x
9. Hooi JKY, Lai WY, Ng WK, Suen MMY, Underwood FE, Tanyingoh D, et al. Global Prevalence of Helicobacter pylori Infection: Systematic Review and Meta-Analysis. Gastroenterology. 2017 Aug;153(2):420–9. doi:10.1053/j.gastro.2017.04.022

10. Skokowski J, Vashist Y, Girnyi S, Cwalinski T, Mocarski P, Antropoli C, et al. The Aging Stomach: Clinical Implications of H. pylori Infection in Older Adults—Challenges and Strategies for Improved Management. IJMS. 2024 Nov 28;25(23):12826. doi:10.3390/ijms252312826
11. Syam AF, Miftahussurur M, Makmun D, Nusi IA, Zain LH, Zulkhairi, et al. Risk Factors and Prevalence of Helicobacter pylori in Five Largest Islands of Indonesia: A Preliminary Study. Ahmed N, editor. PLoS ONE. 2015 Nov 23;10(11):e0140186. doi:10.1371/journal.pone.0140186
12. Sandhika W. Detection Of Helicobacter Pylori Infection In Chronic Gastritis Biopsy Specimen Using Antibodi Monoklonal Helicobacter Pylori And Modified Giemsa Stain In Dr Soetomo Hospital Surabaya. IJTID. 2019 Oct 9;7(6):150. doi:10.20473/ijtid.v7i6.8404
13. Lee JY, Kim N. Diagnosis of Helicobacter pylori by invasive test: histology. Ann Transl Med. 2015 Jan;3(1):10. doi:10.3978/j.issn.2305-5839.2014.11.03 PubMed PMID: 25705642; PubMed Central PMCID: PMC4293485.
14. Tajalli R, Maliheh Nobakht, Hajar Mohammadi-Barzelighi, Agah S, Abdolaziz Rastegar-Lari, Alireza Sadeghipour. The Immunohistochemistry and Toluidine Blue Roles for Helicobacter pylori Detection in Patients with Gastritis. Iranian Biomedical Journal. 1996;3(1):10. doi:10.6091/IBJ.1094.2012
15. Dixon MF, Genta RM, Yardley JH, Correa P. Classification and Grading of Gastritis: The Updated Sydney System. The American Journal of Surgical Pathology. 1996 Oct;20(10):1161–81. doi:10.1097/00000478-199610000-00001
16. Misra V, Misra S, Dwivedi M, Singh ÜPA, Bhargava V, Gupta SC. A topographic study of *Helicobacter pylori* density, distribution and associated gastritis. J of Gastro and Hepatol. 2000 Jul;15(7):737–43. doi:10.1046/j.1440-1746.2000.02240.x
17. Pennelli G, Grillo F, Galuppini F, Ingravallo G, Pilozzi E, Rugge M, et al. Gastritis: update on etiological features and histological practical approach. Pathologica. 2020 Oct 29;112(3):153–65. doi:10.32074/1591-951X-163 PubMed PMID: 33179619; PubMed Central PMCID: PMC7931571.
18. Halim F, Listiana DE, Karlowee V, Istiadi H, Prasetyo A, Astuti MDK. Imunohistokimia Sebagai Lini Kedua Untuk Identifikasi Helicobacter spp pada Biopsi Lambung. Medica Hospitalia J Clin Med. 2023 Nov 29;10(3):312–8. doi:10.36408/mhjcm.v10i3.959
19. Chey WD, Howden CW, Moss SF, Morgan DR, Greer KB, Grover S, et al. ACG Clinical Guideline: Treatment of Helicobacter pylori Infection. Am J Gastroenterol. 2024 Sep;119(9):1730–53. doi:10.14309/ajg.0000000000002968

https://doi.org/10.56303/jhnresearch.v5i2.1124