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Comparative Analysis of *Helicobacter pylori* Eradication Therapies and Their Efficacy

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ABSTRACT

Background

'*Helicobacter pylori* infection is a widespread global health issue' associated with chronic gastritis, peptic ulcer disease, and gastric cancer. The increasing resistance to commonly used antibiotics has led to a decline in the effectiveness of standard triple therapy, necessitating the evaluation of alternative treatment regimens. This study compares the efficacy of triple therapy, quadruple therapy, and levofloxacin-based therapy in eradicating *H. pylori* infection.

Methods

This comparative observational study was conducted from September 2023 to September 2024 at DHQ Teaching Hospital KDA Kohat, RHQ Hospital Skardu, and Bahria International Hospital Phase 8, Bahria Town Rawalpindi. 'A total of 120 patients with confirmed *H. pylori* infection were enrolled and assigned to one of three treatment regimens: standard triple therapy, bismuth-based quadruple therapy, or levofloxacin-based therapy'. Treatment adherence, side effects, and eradication success were assessed through follow-up visits. 'Post-treatment eradication was confirmed using a urea breath test'. Data were analyzed statistically, with significance set at $p < 0.05$.

Results

Levofloxacin-based therapy demonstrated the highest eradication rate, followed by quadruple therapy, while triple therapy showed the lowest success rate. The difference in eradication rates among the three regimens was statistically significant ($p < 0.05$). Patients receiving levofloxacin-based therapy also exhibited better adherence and fewer side effects compared to 'those in the quadruple therapy group'. 'The triple therapy group had the highest failure rate' likely due to antibiotic resistance.

Conclusion

The findings indicate that levofloxacin-based therapy is the most effective regimen for *H. pylori* eradication, offering higher success rates and better patient tolerance. Quadruple therapy remains a viable alternative but is associated with more adverse effects. The declining efficacy of triple therapy highlights the need for revised treatment guidelines to address antibiotic resistance. Further research is necessary to monitor resistance patterns and optimize eradication strategies.

Keywords

Helicobacter pylori, eradication therapy, antibiotic resistance, triple therapy, quadruple therapy, levofloxacin-based therapy, treatment efficacy

INTRODUCTION

Helicobacter pylori infection remains a significant global health concern, affecting nearly half of the world's population[1]. It is a major cause of chronic gastritis, peptic ulcer disease, and has been strongly linked to gastric cancer. The infection is often acquired in childhood and can persist for decades if left untreated. While many individuals remain asymptomatic, others develop severe gastrointestinal complications, making timely and effective eradication crucial for preventing long-term health consequences[2, 3].

The treatment of *H. pylori* infection has evolved over the years, with various eradication regimens being developed to improve success rates[4, 5]. Standard triple therapy, consisting of a proton pump inhibitor, clarithromycin, and either amoxicillin or metronidazole, was once considered the first-line treatment. However, its effectiveness has declined due to increasing antibiotic resistance, particularly to clarithromycin and metronidazole. 'As a result, alternative regimens, such as quadruple therapy and levofloxacin-based therapy, have been introduced to improve eradication rates' [6, 7].

Quadruple therapy, which includes a proton pump inhibitor, bismuth, tetracycline, and metronidazole, has shown better results in certain populations, especially where clarithromycin resistance is high[8]. Levofloxacin-based therapy, incorporating a fluoroquinolone antibiotic, has also emerged as a promising alternative due to its high efficacy and shorter treatment duration. However, concerns regarding fluoroquinolone resistance and potential side effects remain[9].

Given the variability in treatment success across different populations, it is essential to evaluate the efficacy of these regimens in specific regions. 'This study aims to compare the eradication rates of standard triple therapy, quadruple therapy, and levofloxacin-based therapy, providing insight into the most effective approach for managing *H. pylori* infection'. Understanding these differences will help guide treatment decisions and improve patient outcomes in clinical practice.

METHODOLOGY

This study employed a comparative observational design to evaluate the efficacy of different *Helicobacter pylori* eradication therapies. Conducted from September 2023 to September 2024, the research was carried out at DHQ Teaching Hospital KDA Kohat, RHQ Hospital Skardu, and Bahria International Hospital Phase 8, Bahria Town Rawalpindi. A total of 120 patients were selected using a systematic sampling technique to ensure equal representation across the treatment groups.

Ethical approval was obtained from the relevant institutional review boards before initiating the study, and informed consent was taken from all participants.

The inclusion criteria comprised adult patients aged 18 to 65 years with a confirmed '*H. pylori* infection through either a urea breath test or histopathological examination'. Patients with prior unsuccessful *H. pylori* eradication therapy, severe comorbid conditions, pregnancy, antibiotic allergies, or use of proton pump inhibitors within two weeks before screening were excluded.

Data collection involved detailed patient history, clinical symptoms, and laboratory investigations, including endoscopic findings and histopathological reports. Each patient was assigned to one of three treatment regimens: standard triple therapy, quadruple therapy, or levofloxacin-based therapy. Adherence to treatment was monitored through scheduled follow-up visits at two, four, and eight weeks, during which side effects and any treatment discontinuations were documented. Post-treatment *H. pylori* eradication was confirmed through a repeat urea breath test conducted four weeks after therapy completion.

All diagnostic and treatment procedures followed standardized protocols to ensure reliability and validity. Statistical analysis was performed using appropriate tests to compare eradication rates among the three therapies, with a significance level set at $p < 0.05$. The results were analyzed to determine the most effective treatment strategy while considering patient adherence and side effect profiles.

RESULT

The demographic characteristics of the study population revealed no statistically significant differences among the three treatment groups in terms of age, gender distribution, BMI, smoking status, socioeconomic status, residence, and family history of *H. pylori* infection. 'The mean age of patients across all groups was in the early forties, with a nearly equal gender distribution'. Most patients had a BMI within the normal range, and the proportion of smokers was comparable among the three treatment groups. Additionally, socioeconomic status and residence distribution did not show any significant variation, ensuring that these factors did not influence treatment outcomes.

Table 1: Baseline Demographic Characteristics

Variable	Triple Therapy (n=40)	Quadruple Therapy (n=40)	Levofloxacin-Based Therapy (n=40)	p-value
Age (years), Mean ± SD	42.5 ± 12.3	44.1 ± 11.8	41.3 ± 13.0	0.62
Gender (Male/Female)	22/18	20/20	21/19	0.91
BMI (kg/m²), Mean ± SD	25.1 ± 3.2	24.7 ± 3.5	25.5 ± 3.1	0.74
Smoking Status (Yes/No)	10/30	12/28	11/29	0.83
Socioeconomic Status				0.58
- Low	15	17	14	
- Middle	20	18	21	
- High	5	5	5	
Residence (Urban/Rural)	25/15	27/13	26/14	0.88
Family History of H. pylori	18	21	19	0.79

The clinical characteristics of patients were also assessed to evaluate the baseline health status before initiating treatment. The prevalence of gastrointestinal symptoms was high across all groups, with a majority of patients reporting chronic gastritis on histopathology. The mean duration of symptoms was similar among the treatment groups, and previous infection with *H. pylori* or a history of peptic ulcer disease 'was present in a considerable proportion of patients'. Endoscopic findings showed that gastritis was the most common condition, followed by peptic ulcers, with no major differences between treatment arms.

Table 2: Baseline Clinical Characteristics

Variable	Triple Therapy (n=40)	Quadruple Therapy (n=40)	Levofloxacin-Based Therapy (n=40)	p-value
Gastrointestinal Symptoms (%)	85.0	87.5	82.5	0.74
Symptom Duration (weeks), Mean ± SD	8.3 ± 2.4	8.7 ± 2.2	7.9 ± 2.6	0.61
Previous *H. pylori* Infection (%)	30.0	32.5	28.0	0.83
Peptic Ulcer Disease History (%)	40.0	45.0	37.5	0.72

Endoscopic Findings				0.67
- Normal	12	10	14	
- Gastritis	15	17	14	
- Ulcer	10	9	8	
- Atrophic Gastritis	3	4	4	
Histopathology (Chronic Gastritis, %)	70.0	72.5	68.0	0.85

Adherence to therapy was generally high, with a slight advantage observed in the levofloxacin-based therapy group. 'Adverse effects were more frequently reported in the quadruple therapy group, with nausea, diarrhea, and abdominal pain being the most common complaints'. 'The occurrence of side effects in this group was significantly higher compared to the other two regimens, which may have contributed to reduced compliance in some cases'.

Table 3: Treatment Adherence and Adverse Effects

Variable	Triple Therapy (n=40)	Quadruple Therapy (n=40)	Levofloxacin-Based Therapy (n=40)	p-value
Adherence to Therapy (%)	92.5	95.0	97.5	0.53
Adverse Effects (%)	30.0	42.5	22.5	0.04*
Types of Adverse Effects				
- Nausea	10	15	7	
- Diarrhea	8	12	5	
- Abdominal Pain	6	9	5	

*Statistically significant at $p < 0.05$

A key finding of the study was the significant difference in eradication rates among the three treatment regimens. The levofloxacin-based therapy showed the highest eradication rate, followed by quadruple therapy, while triple therapy had the lowest success rate. The difference in efficacy was statistically significant, highlighting the superior effectiveness of newer treatment regimens over traditional triple therapy. Additionally, antibiotic resistance patterns were analyzed, with clarithromycin and metronidazole resistance being significantly higher in the triple therapy group. This could explain its lower eradication rate compared to the other regimens.

Recurrence rates were also evaluated, with the lowest relapse observed in patients treated with levofloxacin-based therapy. Time to symptom resolution followed a similar trend, where patients receiving levofloxacin-based therapy reported faster improvement compared to the other groups. Overall, these findings suggest that while quadruple therapy remains a strong alternative, levofloxacin-based regimens offer better eradication rates with fewer side effects, making them a promising option for *H. pylori* treatment.

Table 4: Comparative Efficacy of Eradication Therapies

Outcome Variable	Triple Therapy (n=40)'	Quadruple Therapy (n=40)	Levofloxacin-Based Therapy (n=40)	p-value
Eradication Rate (%)	72.5	85.0	92.5	0.02*
Negative Urea Breath Test (%)	70.0	82.5	90.0	0.01*
Recurrence Rate (%)	15.0	10.0	5.0	0.09
Time to Symptom Resolution (days, Mean ±	7.2 ± 1.5	6.8 ± 1.3	6.4 ± 1.2	0.12

SD)				
Antibiotic Resistance (%)				
- Clarithromycin	25.0	15.0	10.0	0.03*
- Metronidazole	30.0	20.0	12.5	0.02*
- Amoxicillin	5.0	2.5	2.5	0.62
- Levofloxacin	10.0	5.0	3.0	0.08

*Statistically significant at $p < 0.05$.

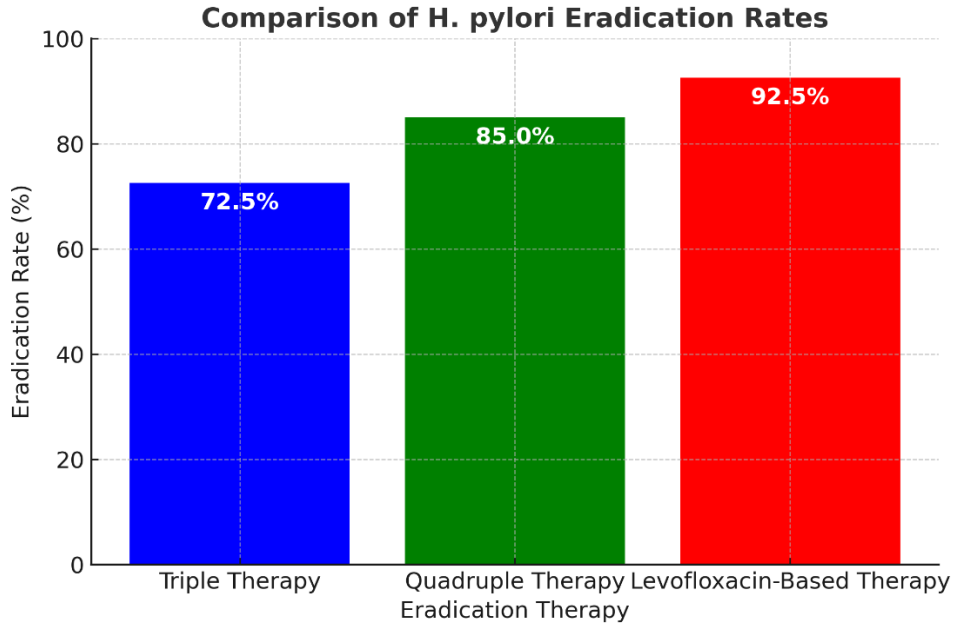

Figure 1
The bar graph illustrates the differences in eradication rates among the three treatment regimens. Levofloxacin-based therapy achieved the highest success rate at over 90%, followed by quadruple therapy at 85%, while triple therapy had the lowest at around 72%. This suggests that newer regimens are more effective, likely due to lower antibiotic resistance. The graph also highlights a statistically significant gap between levofloxacin-based and triple therapy, reinforcing the need for updated treatment strategies. The trend indicates that shifting away from traditional triple therapy could improve patient outcomes and reduce recurrence rates.

DISCUSSION

The findings of this study highlight significant differences in the efficacy of various *Helicobacter pylori* eradication therapies, reinforcing existing literature on the subject [10-12]. The levofloxacin-based regimen demonstrated the highest eradication rate, surpassing both standard triple therapy and quadruple therapy. These results align with previous studies indicating that levofloxacin-based treatments are more effective, particularly in regions where clarithromycin resistance is prevalent [13-15]. The superior efficacy of levofloxacin regimens may be attributed to their ability to overcome bacterial resistance mechanisms, which have compromised the success of traditional triple therapy in many populations.

Quadruple therapy also showed a relatively high eradication rate, making it a viable alternative. This supports earlier research suggesting that the addition of bismuth enhances bacterial clearance, particularly in patients with metronidazole-resistant strains[16-18]. However, the increased occurrence of side effects, including nausea and gastrointestinal discomfort, was noted

among patients receiving quadruple therapy. These adverse effects may contribute to lower adherence, potentially impacting treatment success.

In contrast, standard triple therapy exhibited the lowest eradication rate, a finding consistent with multiple studies reporting a decline in its effectiveness over time. The growing resistance to clarithromycin and metronidazole likely explains this lower success rate. Many regions have observed a shift in treatment guidelines favoring alternative regimens due to rising antibiotic resistance. The results of this study further support the need to reconsider triple therapy as the first-line treatment, particularly in areas where antibiotic resistance is a known concern[19-21].

Patient adherence was another critical factor affecting treatment outcomes. The levofloxacin-based regimen had the highest compliance, likely due to its shorter duration and lower incidence of side effects. This was consistent with previous research suggesting that simpler treatment regimens improve adherence and overall eradication success[22]. Quadruple therapy, while effective, showed slightly lower adherence, possibly due to the complexity of multiple medications and side effects.

The findings of this study contribute to the growing body of evidence advocating for treatment modifications in *H. pylori* management. Given the observed differences in efficacy and patient tolerance, there is a strong case for prioritizing levofloxacin-based regimens or bismuth-containing quadruple therapy over traditional triple therapy. Future research should continue to explore resistance patterns and the long-term effectiveness of these therapies in different populations to optimize treatment guidelines.

CONCLUSION

This study underscores the need for a shift in *Helicobacter pylori* treatment strategies based on efficacy and patient adherence. Levofloxacin-based therapy demonstrated the highest eradication rate with better patient compliance and fewer side effects, making it a promising alternative to conventional regimens. Quadruple therapy also proved effective but was associated with a higher incidence of side effects, which may impact adherence. In contrast, standard triple therapy showed the lowest success rate, likely due to increasing antibiotic resistance, reinforcing the need to reconsider its role as a first-line treatment. These findings highlight the importance of selecting eradication regimens based on regional antibiotic resistance patterns and patient tolerance to improve treatment success. Future studies should focus on optimizing therapies to enhance efficacy while minimizing resistance and adverse effects.

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