



COMPARISON AND EFFICACY IN DIAGNOSTIC METHODS OF HELICOBACTER PYLORI INFECTION.

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Summary

Introduction: *Helicobacter Pylori* is the bacterium that infects more than half of the world's population, it is responsible for developing chronic gastritis, causing in some cases peptic ulcers, MALT-type lymphomas (mucosa-associated lymphoid tissue) and gastric cancer. Its prevalence varies in developed countries, specifically in the European Union and the United States, it is around 14% to 40%, while in countries such as Latin America it fluctuates between 60 and 80%. Its classic symptoms are epigastralgia, satiety, nausea, vomiting and in case of bleeding; melena, hematemesis and anemia. In Ecuador, 47.66% of patients do not manifest symptoms, but their identification is essential since they allow actions to be carried out to stratify the risk and allow timely treatment, avoiding progression to complicated conditions. Invasive methods have been developed for its diagnosis, based on rapid urease testing, microbial culture, histological evaluation and molecular tests, and breath tests, stool antigen tests and serological detection of antibodies as non-invasive methods. In such methods, their use will depend on a number of factors. So far, vaccines have been developed that confer long-lasting immune protection against infection by this microorganism, the development of these becomes valid considering that 50% of the world's population is infected and that the use of a vaccine can be an alternative to treatment failure

General objective: to describe and compare the diagnostic methods of *Helicobacter pylori* infection considering their efficacy

Methods: Systematic review using PubMed Central, Elsevier, Scopus, Web of Science databases. Scientific articles published during the period 2018-2023 in Spanish and English, and indexed in Journal Citation Reports and/or Scimago Journal & Country Rank (quartiles 1 to 4) were included.

Results: The evidence found in the literature review in several databases indicates that within the invasive diagnostic methods, upper gastrointestinal endoscopy with histological evaluation is considered as the gold standard, while in the non-invasive methods the exhaled air test is mentioned as the best option.

Conclusions: It is essential to know and differentiate its usefulness in the different diagnostic methods for *H. pylori* infection available in the environment so far, either as a de novo or eradication diagnosis so that an adequate therapeutic approach can be carried out.

Keywords: diagnosis; gastritis; *Helicobacter pylori*; symptomatology; Vaccines

INTRODUCTION

Helicobacter pylori (*H. pylori*) is the most common chronic bacterial infection in humans, being the only bacterium that infects the gastric mucosa, despite being the most dominant among bacteria, it does not behave as a classic bacterial pathogen, because the development of the disease depends on a complex relationship between pathogens, and environmental factors. In Latin America, its estimated prevalence is 70-90%, although it can vary significantly within the same territory and between different countries (1-7).

When mentioning its symptoms, in all infected people this bacterium causes chronic gastritis; However, in most cases the disease is asymptomatic. In less than 20% of cases of the infection there will be clinical manifestations, given by peptic ulcer disease in 15-18% of cases and in a smaller proportion, gastric cancer and gastric MALT lymphoma, with about 2% and less than 1% of cases, respectively. In addition, due to its participation in the etiology of various clinical conditions, it generates considerable morbidity and mortality, causing an impact on the quality of life and health systems of the population, making its timely diagnosis and treatment important both to attenuate the severity of the disease and for the prevention of gastric cancer (7-13).

Thus, different methods are used to make a de novo diagnosis or follow-up of the disease associated with the infection. Traditionally, diagnosis has been made through a combination of tests, both invasive and non-invasive. Considering the wide spectrum of diagnostic methods, in clinical practice under certain circumstances, tests with high diagnostic accuracy should be used, and currently, it is taken into account that their sensitivity and specificity are greater than 90%. The choice of the method to be used depends on the clinical circumstances of the patient to be evaluated, the availability of the test, the probability ratio of positive and negative results, and its cost-effectiveness (14-18).

The following review provides an overview of diagnostic methods for evaluating *H. pylori* infection. Therefore, it is necessary to mention the factors that may alter its diagnostic result, in addition to describing its sensitivity and specification in each of the tests, as well as associated clinical conditions to be taken into account to achieve success in the diagnosis.

MATERIALS AND METHODS

Literature review, narrative type. For this purpose, a search strategy was carried out for articles related to the research topic in databases, such as: PubMed, Science direct, Scopus and Dynamed. The information search mechanism was accompanied by the use of keywords such as: "DIAGNOSTIC METHODS BY *HELICOBACTER PYLORI*" "CHOICE FACTORS FOR DIAGNOSIS" "INFECTION SYMPTOMS", with the help of bibliographic descriptors such as DeCs/MeSh, in English and Spanish of the last five years and in order to optimize the results, Boolean operators such as "NOT" were used. "OR" and "AND", which refer to the inclusion and exclusion of terms, in order to optimize accuracy.

The collected articles went through different stages of screening, in order to work exclusively with those that met all the eligibility criteria defined in advance. Among them were, that, in the first place, they were all exclusively articles. That they alluded to the topic implicitly or explicitly and that they had an important relationship with the pre-defined objectives.

That they had years of publication after 2018, in English and Spanish languages exclusively. But they should not have restricted access either, whether by payment or another variant. And that they were fully available on the aforementioned digital platforms.

RESULTS

The information was then processed in tables, in the same order as the objectives. A total of 9 articles were used in this section, which contained a direct relationship with the objectives of this research. The results were processed in tables, each corresponding to the objectives:

- To describe and compare the diagnostic methods of *Helicobacter pylori* infection, considering their efficacy.
- To characterize the most frequent clinical manifestations of *H. pylori* infection.

- To describe the most important associated factors in the choice of the diagnostic method of H. pylori infection.

- Review future prospects and advances related to H. pylori infection

Sabbagh et al. 2019, mentions that H. pylori infection represents a key factor in the pathogenesis of duodenal ulcer and chronic gastritis, so a reliable method to detect infection by this bacterium is still a crucial question and remains a topic of active debate. The tests applied for diagnosis are grouped into invasive and non-invasive methods. Invasive methods consist of endoscopic evaluation, rapid urease testing, histology, and bacterial culture. Non-invasive tests include urea breath test, stool antigen test, serology, and molecular diagnostic approaches. When talking about the use of endoscopy, this is a prerequisite for all invasive methods and poses difficulties in children, as it is a difficult procedure and requires the cooperation of the patient. For this reason, non-invasive tests have commonly been used in children, although their accuracy is not very reliable in some cases. Invasive tests can be opted for to confirm the diagnosis when necessary (19-25).

Arnoldo et al. In his article he recommends within the invasive methods for greater diagnostic accuracy in the taking of biopsy, the obtaining of a minimum of 3 biopsies from 2 different locations at the gastric level, which include at least the antrum and the body, the specific locations of these three would be at the level of the angularis incisura, at the level of the greater curvature of the body and another of the greater curvature at the level of the antrum. He also mentions a Canadian study, where electronic records of patients were taken to evaluate them regarding the location of gastric biopsy and the use of proton pump inhibitors to endoscopy, being 150 cases with biopsies taken from both the antrum and the gastric body, these were randomly selected for pathological review with special stains. samples were taken from different gastric regions and the distribution of H. pylori and the influence of clinical factors on pathological interpretation were assessed, confirming that the use of PPIs during endoscopy contributes to a false diagnosis and that taking a gastric biopsy from only one region increases the possibility of missing the active infection by at least 15%. On the other hand, Smith et al. 2019., in a retrospective study in which 200 gastric mucosal samples taken consecutively were taken into account, corroborated that H. pylori is easily observed in most cases in which hematoxylin-eosin is used (Sensitivity 91% and Specificity 100%), remaining the most convenient and least expensive to identify H. pylori in gastric biopsies (26-34).

In addition, Arnoldo et al. They developed an informative systematic review and meta-analysis, which included 31 articles and 135 studies conducted between January 1998 and May 2009, in order to evaluate the performance of the carbon-13 urea breath test in the diagnosis of H. pylori infection in children, the included studies compared the test with another considered gold standard and the children were stratified into age subgroups of less than 6 years and greater than or equal to 6 years, demonstrating adequate diagnostic accuracy at all ages combined, with sensitivity of 95.9% and specificity of 95.7%; high diagnostic accuracy in patients over 6 years of age with sensitivity of 96.6% and specificity of 97.7%; and variability in children under 6 years of age, with sensitivity of 95% and specificity of 93.5%. The authors identified as possible sources of heterogeneity in the results: the dose of the marker, the food consumed prior to the test, and the value of the cut-off point; noting that using doses of 50 mg carbon-13 demonstrated better diagnostic accuracy when adjusted for body weight and outperforming that of studies using doses between 50 and 75 mg (9,34).

On the other hand, Chahuan, et al. 2022, mentions a review that included 29 studies evaluating the antigen in H. pylori stools in almost 3,000 patients, with 1,311 positive cases for H. pylori infection, showed a sensitivity of 83% (with a fixed specificity of 90%). In our setting, the antigen in H. pylori stools is very useful, especially to confirm the effectiveness of the treatment, given the great availability and ease of performing it, compared to upper gastrointestinal endoscopy or the exhaled air test. In addition, he mentions that cost-effectiveness studies have been carried out on the test of exhaled air with urea for the diagnosis of this bacterium, through the strategy of testing and treating, in patients with dyspepsia, and it has been compared with symptomatic management and upper gastrointestinal endoscopy as a first approximation. For the goal of relieving dyspepsia, the strategy of testing and treating through the use of exhaled breath testing is the most cost-effective. Other cost-effective outcomes included the prevention of peptic ulcer disease and the development of gastric

cancer. The sensitivity of this method exceeds 90% in different meta-analyses. The high sensitivity and specificity adds to the acceptance of patients since it is an easy test to perform and can be carried out in a single visit to the clinical unit, making it the most widely used non-invasive methods in the outpatient clinical setting. Within its limitations, the exhaled air test is considered to be at high risk of Sars-Cov-2 transmission (9,15).

Ordoñez. 2018, also mentions that histopathological examination is one of the most useful tests and is considered by some to be the gold standard for the detection of H. pylori. Experts agree that its main advantage is that it allows direct observation of the pathological changes associated with the infection, which, if the germ cannot be detected, these changes would represent markers of H. pylori infection (13).

However, Chahuan, 2022 et al. mentions that although there are numerous diagnostic methods, there is no defined gold standard, due to the limitations of each of the tests, so in some articles the sum of more than one diagnostic test is considered as the gold standard. For this reason, when evaluating a new diagnostic test, it is essential to analyze the means and conditions in which it is carried out (15).

Stalemate

• Objective Table No. 1 • To describe and compare the diagnostic methods of Helicobacter pylori infection, considering their efficacy.

Method	Advantages	Limitations
Non-invasive		
Urea Breath Test	High Accuracy Useful before and after treatment	Low specificity and high false-positive results - In children (younger than 6 years) a false-negative result - Outcomes in Bismuth and Antibiotic Recipient Patients
Stool antigen test	Fast, easy and cost-effective No age dependency Helpful before and after therapy	False-Negative Results in Bismuth and Antibiotic Recipients
Serology	Cheap and widely available	Inability to detect acute vs chronic infections Low sensitivity in children, unreliable to confirm eradication of infection
Invasive		
Histology	Observation of the degree of atrophy	Observer dependency It takes time Expensive Dependence on precision in the use of PPIs and antibiotics
Rapid urease test	High sensitivity (80%) and specificity (almost 100%) Fast & Cheap	Dependence on the accuracy of the number and location of the biopsy
Cultivation	Determining the Antimicrobial Pattern Resistance High specificity (100%)	Expensive and time-consuming testing
Non-invasive or invasive		
Polymerase chain reaction (PCR)	Fast High sensitivity and specificity Determining Antimicrobial Susceptibility	False-positive results due to detection of DNA fragments from dead bacteria

Source: Malfertheiner P. et al., Helicobacter pylori infection, 2023.

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On the other hand, Pérez, 2021 et al., mentions us in their diagnostic study carried out on a total of 25 patients with H. pylori infection. The prevalence rate was 59.5%, higher in patients over 65 years of age (80%), men (68%), and women (47%). Regarding the clinical profile of the typical patient diagnosed with peptic ulcer, their symptoms would be compatible with dyspeptic syndrome (46.7%),

with a single ulcer (62.1%) of duodenal location (95.3%), in the active phase (74.4%) and without intestinal metaplasia (92.8%). On the other hand, the presence of H. pylori in the gastric mucosa is the most strongly associated risk factor known for the development of gastric cancer. Epidemiological studies have estimated that in its absence 75% of gastric cancers would not exist, being considered the most common causative agent of cancer attributable to infection and responsible for 5.5% of all cancers worldwide (34 -36).

Objective Table No.2. • To characterize the most frequent clinical manifestations of H. pylori infection.

Author	Year	Country	Sample	Type of research	Prevalence of H. pylori	Clinical manifestations
Orellana et al.,	2019	Cuba	242	Descriptive study	40,5%	Pain in the epigastrium
Castro et al.,	2021	Ecuador	131	Cross-sectional study	39%	Dyspepsia
Canedo	2021	Lebanon	300	Cross-sectional study	41%	Epigastric pain Heartburn Regurgitation Nausea
Perez et al.,	2021	Cuba	42	Descriptive study	59,5%	Dyspeptic syndrome
Anzulez et al.,	2021	Colombia	248	Cross-sectional study	45%	Early satiety when eating Feeling of emptiness in the stomach Heartburn Mild nausea Pain in the epigastrium
Mere	2019	Ecuador	88	Systematic review	35%	Heartburn Nausea Diarrhoea Pain in the epigastrium
Pine	2020	Cuba	223	Descriptive study	49%	Early satiety when eating Nausea Pain in the epigastrium
Balamtekin et al	2019	Spain	156	Correlational study	29%	D
Rosales et al	2021	Cuba	92	Documentary study	42%	Heartburn and pain in the epigastrium Loss of appetite
Morales et al	2019	Ecuador	97	Cross-sectional study	37%	Dyspepsia Pain in the epigastrium Heartburn

Source: Mendoza and Lucas, 2022. Helicobacter pylori: Risk factors and clinical manifestations in adults.

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Table no. 3 • To describe the most important associated factors in the choice of the diagnostic method of H. pylori infection.

Test	Sensitivity	Specificity	Clinical use	Keep in mind
Invasive Methods				
Rapid urease test	84-95%	95-100%	<ul style="list-style-type: none"> • Important for Initial Diagnosis • Testing Two Biopsy Specimens Improves Sensitivity • Provides fast results 	<ul style="list-style-type: none"> • Proton Pump Inhibitors (PPIs) must be discontinued 14 days prior to testing • Current or recent antibiotic

				therapy needs to be excluded
Microbial culture	76-90%	100%	<ul style="list-style-type: none"> • Important for phenotypic susceptibility testing 	<ul style="list-style-type: none"> • Absolute but costly specificity • PPIs must be discontinued 14 days prior to testing • Current or recent antibiotic therapy needs to be excluded
Histological evaluation	60-93%	Greater 95%	<ul style="list-style-type: none"> • Gold Standard for Diagnosis and Evaluation of Mucosal Changes 	<ul style="list-style-type: none"> • Based on the updated Sydney system
Molecular testing (PCR and FISH methods)	80-95%	100%	<ul style="list-style-type: none"> • Useful in initial diagnosis and follow-up • Provides fast results 	<ul style="list-style-type: none"> • High sensitivity and specificity • Useful in gastrointestinal bleeding, virulence typing, and detection of antibiotic resistance
Non-invasive methods				
Breath test with 13C urea	95-100%	95-100%	<ul style="list-style-type: none"> • Gold Standard for Non-Invasive Diagnostics • Higher sensitivity and specificity than stool antigen test and serological evaluation • For initial diagnosis and follow-up 	<ul style="list-style-type: none"> • PPIs must be discontinued 14 days prior to testing • Current or recent antibiotic therapy needs to be excluded
Stool antigen test	Greater than 95%	Greater than 95%	<ul style="list-style-type: none"> • Useful for initial diagnosis and follow-up • Slightly lower sensitivity than UBT 	<ul style="list-style-type: none"> • Fast, simple and economical
Serological detection of antibodies	74,4%	59%	<ul style="list-style-type: none"> • Useful for initial diagnosis in specific cases 	<ul style="list-style-type: none"> • Cheap, simple and fast • Highly variable results

				<ul style="list-style-type: none"> • Ideal for epidemiological purposes • PPIs do not need to be discontinued and are useful in patients with gastrointestinal bleeding • Can't distinguish between active and previous infection
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Source: Malfertheiner P. et al., Helicobacter pylori infection, 2023.

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In relation to new diagnostic proposals, Yao-Kuang W et al. used gastric juice obtained from 815 patients during an endoscopic study to test for antimicrobial susceptibility to clarithromycin (CLA) and levofloxacin (LEV), and to determine genotypes of CYP2C19 and IL-1 β -511, comparing their diagnostic efficacy with traditional methods. They also performed rapid urease testing, histology, breath test, and culture. They reported: sensitivity 90.5%, specificity 96%, positive predictive value 92.7%, negative predictive value 94.7% and efficacy for infection detection 94%. In 33 patients with determination of polymorphisms for CYP2C19 and IL-1 β -511 in blood, the result in gastric juice showed 100% agreement. In 128 patients with CLA susceptibility testing and 44 patients with LEV, the concordance in specific mutation sites for each antibiotic was 100%, with SEN and ESP > 85%, leading to the conclusion that gastric juice analysis can be effective in detecting H. pylori infection, antibiotic resistance, and host genetic polymorphisms (33).

On the other hand, when talking about the most recent advances for the eradication of H. pylori Esquivel. 2017, mentions that in a study they evaluated the intensity and extent of immunohistochemistry stains for epidermal growth factor receptor (EGFR) of gastric biopsies in a cohort of Colombian patients after successful eradication and 6 years later with new endoscopic biopsies, and corroborated the absence of infection. At the same time, they report the effect of gefitinib (an antineoplastic drug that specifically inhibits EGFR activation) as a prophylactic agent in gastric inflammation and the development of H. pylori-induced cancer. They determined EGFR in epithelial cells of transgenic mice infected with H. pylori and fed gefitinib. They quantified cytokine expression (Cxc/1 and Cxc/2), inflammatory infiltrate, and DNA damage. The results show that in the biopsies of patients with atrophic and non-atrophic gastritis who received antibiotics and who remained negative for H. pylori at 6 years, immunohistochemical markers for EGFR did not decrease and even a moderate increase was observed. On the other hand, mice fed gefitinib demonstrated a significant reduction in cytokine expression, inflammatory infiltrate, and DNA damage induced by H. pylori infection, with consequent decrease in dysplasia and cancer. (35,36)

Finally, Urrego, 2017. A significant advance was recently made in a randomized, double-blind clinical trial compared to placebo, which is the first phase 3 study of a potential H. pylori vaccine. This study used a vaccination schedule with three doses of a vaccine composed of urease B as an antigen and as an adjuvant, the B subunit of TL, with lower toxicity. The vaccine was given to 2,232 children with no current or previous infection and the same number of children received the placebo. After comparing the rate of infections detected in the vaccinated group with that of the placebo group, an effectiveness of 71.8% was found at one year and 55.8% at three years. When analysing the results,

some experts consider that some drawbacks need to be resolved, such as the rapid fading of the protection conferred by the vaccine, which would almost certainly increase with greater follow-ups, or the need for a high number of doses in a context of already saturated national vaccination plans. However, this phase III study has shown for the first time that it is possible to protect the community against future *H. pylori* infection through vaccination (31).

DISCUSSION

Arocano and Velez 2021 mention that *H. pylori* affects about two-thirds of the world's population. Its presence varies significantly between regions and its prevalence is strongly related to socioeconomic conditions. In recent decades, there has been a trend towards a gradual decrease in the prevalence of infection by this pathogen in Western countries; however, a similar phenomenon has not been observed in areas with higher prevalences such as Asia, Africa and South America. The relationship in prevalence of infection in several studies analyzed in the current research was approximately 60%. In developed countries, it is usually located in around 50% or less of the general population. However, higher figures have been found in other studies (7).

Mendoza et al. Within the analysis in its systematic review, it mentions that the most common clinical manifestations related to *H. pylori* infection in adults are heartburn, nausea, epigastric pain, regurgitation, early satiety when eating and less frequent loss of appetite and dyspepsia, reported in the countries of Spain, Cuba; Lebanon, Ecuador and Colombia. This coincides with the studies carried out by Cordeiro L and Bittencourt B, 2020) which report that the associated clinical manifestations are epigastric pain, heartburn, heartburn and regurgitation. This is consistent with (Estrella Cervantes-García, 2019), which describes that heartburn, epigastric pain, nausea and diarrhea are manifestations associated with the infection. (Fierro P, Hidalgo M, Perez B, 2021), identified that early satiety when eating, heartburn, mild nausea and stomach pain are more common clinical manifestations in patients infected by *H. pylori*, at the same time it coincides with (Garai J, Zabaleta M, 2020), which state that nausea and early satiety when eating are clinical manifestations of the bacteria. On another level (Gravina A, Zagari R, Musis C, Romano L., 2019), they indicate that the main clinical manifestation produced by *H. pylori* is dyspeptic syndrome (1,2,37).

On the other hand, Miqueleiz and Alba 2020, in their article, mentions that extrinsic factors such as the quality of the samples constitute a possible limitation, self-medication with antibiotics, the difficulty of identifying the microorganism by laboratory methods, among others, constitute limitations in the choice of diagnosis (32).

Cho et al. 2021 in their study tells us that the data on the presence of *H. pylori* were collected from the results of two diagnostic methods: the antigen immunological test for the detection of this bacterium in fecal samples, which quantitatively measures its concentration in the gastric mucosa and the histopathology of a biopsy by upper gastric endoscopy, taking into account the hypodense predisposition in the tissue according to the Sydney classification (38).

In 2017, the authors of a study conducted in Havana, Cuba, observed an 85.25% sensitivity in the fecal antigen detection test, a specificity of 92.50%, a positive predictive value of 94.5%, and a negative predictive value of 80.43%, all with a diagnostic reliability level of 95%. These results led them to recommend this test as a substitute for gastric endoscopy. Epidemiological characteristics in populations from Central America and Asia, where a serological method was applied for the diagnosis of *H. pylori*, made it possible to observe the existence of false negatives that were corrected through the stool antigen method, so this research team also recommended it as reliable (16).

A literature review that presents data from countries in Africa, Latin America, and the Caribbean highlights that most patients with histological specimens that reflected chronic gastritis also had *H. pylori* infection. In a study conducted in a pathological anatomy service in the city of Santiago de Cuba, it was reported that 70.5% of the study population with a disease in the upper digestive tract tested positive for *H. pylori* infection (9,34).

Icaza L. et to 2021 et al., Most antigen test results for the detection of *H. pylori* in feces were negative. Moderate active chronic gastritis was the most frequent mucosal lesion. The reports of the stool antigen tests and histopathology allowed us to appreciate differences between them, but with a

predominance of coincidences in the positive diagnoses. The association between inflammatory lesions of the gastric mucosa resulting from chronic atrophic gastritis and *H. pylori* infection was statistically significant. The results of the two diagnostic tests had a positive and weak linear correlation with statistical significance (30).

On the other hand, when talking about the most recent advances such as methods of eradication of infection by this bacterium, Esquivel. 2018., mentions that carcinogenesis associated with *H. pylori* infection has been one of the areas of increased research in recent years. The actual effect of eradication on cancer prevention is not yet well defined, but early activation of the epidermal growth factor receptor (EGFR) has been shown to be involved in DNA damage and cancer development. It is concluded that eradication of *H. pylori* alone may not be sufficient to reduce epithelial EGFR expression, which opens up the possibility that adjuvant therapies such as gefitinib may be required to prevent progression to gastric cancer (33,34).

Urrego, 2017. Et al mentions that several vaccination strategies have been tested against *H. pylori* including different types of antigens, adjuvants and routes of administration, with urease being the most used antigen, Cholera Toxin (TC) and *E. coli* Thermolabile Toxin (TL) the most widely used and successful adjuvants. although several molecules and some derivatives of them have shown promise. Most combinations of antigens, adjuvants, and routes of administration have had some degree of success, usually ranging from one to two logarithms in bacterial load, so sterilizing immunity has rarely been achieved in animals and never in humans. Also interesting is the fact that there is no involvement of antibodies in this response to the vaccine, while the involvement of Th cells and, curiously, mast cells seems evident (35).

CONCLUSIONS

The clinical manifestations and severity of gastric diseases depend on the virulence of *H. pylori*. On physical examination, findings are nonspecific and often absent. However, among the symptoms, it is concluded that they most frequently present heartburn, nausea, epigastric pain, regurgitation, early satiety when eating and less frequently loss of appetite and dyspepsia. As for their diagnosis, this will continue to be a topic of great interest due to the associated difficulties that they can present. Thus, despite all the advances made and the recent contributions of all the available diagnostic methods, it has not been possible to establish an ideal one for its diagnosis. The characteristic contributions of each diagnostic method are useful and correspond to the criteria of the health personnel in making the decision of the method or methods to be performed according to the specific context in which the presence of *H. pylori* is to be evaluated. Finally, within the recent advances related to vaccines for the eradication of *H. pylori*, it must be recognized that the current situation is still considerably far from achieving an effective vaccine. The lack of knowledge about the mechanisms of host response to the vaccines that have been evaluated is one of the factors that contributes to the failure to obtain them. However, we should not give up on its search, as there has definitely been progress and some data suggest that its achievement is possible with the enormous benefits to the health of the population that this would imply.

RECOMMENDATIONS

- Greater care should be taken at the first level of care to identify patients with risk factors such as overcrowding, age, low socioeconomic status, inadequate hygiene measures and, less commonly, lack of knowledge of the bacteria, consumption of unsafe water, inadequate washing of food, and a family history of gastritis. From this level we can carry out promotion and prevention measures to avoid the increase of this gastric infection.
- It is recommended that after diagnosing and treating *H. pylori* infection, a diagnostic test be performed again to show eradication of the infection four weeks after the end of treatment.
- Awareness must be raised in the population and within the health area in first-level care with the appropriate use of antibiotics and their resistance to it in case of abandonment of treatment.
- It is suggested in future studies to take into account new drugs used for the eradication of *H. pylori* infection and virulence factors related to advances in vaccines.

FINANCING:

This literature review was self-funded by the authors.

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