H. pylori: who to test and how to treat

Helicobacter pylori infection increases the risk of peptic ulcer disease and gastric cancer due to long-term inflammation and atrophy of the stomach mucosa. Deciding who to test for infection with *H. pylori*, and what treatment regimen to prescribe, is influenced by several factors, including geographic location and ethnicity.

KEY PRACTICE POINTS

- The overall prevalence of *H. pylori* is low in New Zealand compared to the rest of the world; infection is more likely in Māori, Pacific and Asian people compared with New Zealand Europeans
- Most people with *H. pylori* infection will remain asymptomatic; if symptoms do occur, patients are most likely to present with dyspepsia-like symptoms
- In patients who present with new-onset dyspepsia-like symptoms, check for red flags (e.g. symptoms and signs of gastrointestinal bleeding), advise lifestyle modification and prescribe a proton pump inhibitor (PPI) for a short trial period, e.g. four weeks
  - If there is no improvement in symptoms, reiterate the importance of lifestyle modification and consider the patient's risk for *H. pylori* infection
- The decision to test for *H. pylori* in symptomatic people depends on a risk assessment based on multiple factors, including the patient's ethnicity, country of birth, regional infection risk and severity of symptoms
- For patients who are at:
  - High risk of *H. pylori* infection – consider faecal antigen testing. Patients will need to have stopped taking a PPI two weeks before testing.
  - Low risk of *H. pylori* infection – continue PPI treatment and investigate other potential causes. If none can be found or symptoms still do not resolve after alternative treatment options have been trialed, *H. pylori* testing can be considered, or refer patient to secondary care.
- Faecal antigen testing is the preferred investigation for *H. pylori*; serology testing is generally not recommended because it does not differentiate between current or past infection
- If infection with *H. pylori* is confirmed, first-line treatment is a 7 – 14-day course of omeprazole, clarithromycin and amoxicillin (or metronidazole)
- If first-line treatment is unsuccessful, consider if the risks of further antibiotic treatment outweigh the benefits, particularly if it seems likely that the symptoms are unrelated to the infection
- If the patient is still symptomatic after three months and testing confirms that *H. pylori* is still present, the second-line treatment regimen includes omeprazole, metronidazole, colloidal bismuth and tetracycline

H. pylori infection increases the risk of gastric-related adverse effects

H. pylori is a gram-negative bacterium that is associated with long-term gastric inflammation.[1] Infection generally occurs in childhood, although there is debate regarding the exact mode of transmission; oral-oral and faecal-oral are the most likely routes, especially between mothers and infants.[2]

The majority of infected people will remain asymptomatic, with *H. pylori* forming part of their normal gastric microflora.[3] However, in some people *H. pylori* infection can result in dyspepsia-like symptoms (which may be unresponsive to gastric acid suppression) or peptic ulcer disease.[2] In some cases, early *H. pylori* infection can lead to the development of significant gastric malignancies later in life, e.g. gastric mucosa-associated lymphoid tissue lymphoma and non-cardia gastric adenocarcinomas.[1, 2, 4] People with *H. pylori* infection have a lifetime risk of 10 – 20% for peptic ulcer disease and 1 – 2% for stomach cancer.[5] In people taking non-steroidal anti-inflammatory drugs (NSAIDs), *H. pylori* infection can also increase the risk of developing gastric bleeding or a gastroduodenal ulcer.[2]

The prevalence of *H. pylori* in New Zealand is low by global standards

The global prevalence of *H. pylori* infection is > 50%.[2] Rates of infection are higher in Africa (79.1%), Asia (54.7%) and Latin America and the Caribbean (63.4%), while a lower prevalence is reported in Europe (47.0%) and Oceania (24.4%).[6] Prevalence has declined in many countries due to improvements in treatment and in standards of living, but there continues to be marked variation between, and within, countries.[2] This is likely due to the different factors that influence rates of infection with *H. pylori*, including ethnicity, socioeconomic status and younger age.[2, 6] Rates remain higher in developing countries due to associations with increased transmission in areas with overcrowded living conditions, poor sanitation and unsafe drinking water.[2, 6]

While the prevalence of *H. pylori* infection in New Zealand is low compared with many other developed countries, there is variation between ethnic and regional groups.[2, 6] A small 2013 study in South Auckland found a significantly higher prevalence of *H. pylori* infection in Māori (34.9%), Pacific (29.6%), East Asian (23.8%) and Indian (19.2%) peoples, compared with New Zealand Europeans (7.7%); the overall prevalence of *H. pylori* across all ethnicities was 18.6%.[7] A 2015 study showed that while *H. pylori* infections in New Zealand have decreased over time, the difference in comparative risk between New Zealand Europeans and Māori and Pacific peoples is increasing.[5] This is consistent with Māori and Pacific peoples experiencing higher rates of social deprivation and household overcrowding.[8] Chronic *H. pylori* infection is associated with the development of distal gastric cancers; Māori have both higher incidences of *H. pylori* infection and distal gastric cancers, compared with non-Māori in New Zealand.[9]

A risk-based approach is recommended for *H. pylori* testing in New Zealand

There are no recent New Zealand guidelines available on the management of *H. pylori* infection (or dyspepsia). Regional advice differs and there is no published national expert consensus. We therefore present a pragmatic approach based on international guidelines, research, expert guidance and our knowledge of the general practice environment. We recommend that you also consult your local HealthPathways for specific referral advice.

If people with *H. pylori* infection become symptomatic most will present with dyspepsia-like symptoms such as pain, burning or discomfort in the upper abdomen, which can also be associated with bloating, early satiety, nausea or vomiting.[10] It is not recommended to routinely test all patients with dyspepsia-like symptoms for *H. pylori* nor prescribe empiric eradication treatment for *H. pylori* without testing. Testing asymptomatic patients for *H. pylori* infection is not recommended but it may be necessary in some cases, e.g. patients requiring long-term NSAID treatment or patients with a family history of gastric cancer.[11, 12]

After considering red flags (see: "Red flags for people presenting with dyspepsia"), and modifiable factors such as NSAID use, first-line management for patients with dyspepsia-like symptoms is to offer lifestyle modification advice (see: "Lifestyle modifications can help to manage dyspepsia symptoms") and trial a proton pump inhibitor (PPI) for a short duration, e.g. four weeks. If symptoms resolve, *H. pylori* infection is unlikely to be the primary cause of the original symptoms.

Lifestyle modifications can help to manage dyspepsia symptoms

Changes in diet and behaviour can help patients reduce symptoms of dyspepsia. Examples include:[10, 13–15]

- Reducing the size of meals
- Avoiding large meals before bedtime
- Limiting intake of dietary fat and alcohol
- Avoiding foods that trigger dyspepsia symptoms, e.g. chilli or coffee
- Reducing body weight
- Smoking cessation
- Avoiding over-the-counter use of NSAIDs
- Stress management, e.g. cognitive behaviour therapy

If the patient's symptoms do not improve after a PPI trial, consider how likely it is that *H. pylori* will be present, based on factors including:

- Geographic location – *H. pylori* prevalence is generally higher in Northland and Auckland regions compared to the South Island[5]
- Ethnicity – the prevalence of *H. pylori* is higher in Māori, Pacific and Asian peoples (~19 – 35%) than in New Zealand Europeans (≤ 7%)[7]
- Place of birth – prevalence of *H. pylori* is higher in people who were born in developing countries and people who immigrate retain a prevalence of *H. pylori* similar to their country of origin[16]

If *H. pylori* infection is considered likely, then faecal antigen testing is indicated (see: "Faecal antigen testing is recommended to detect *H. pylori* infection"). In cases where infection is considered unlikely, then continue PPI treatment and investigate/manage other potential causes. If none can be found or symptoms still do not resolve after alternative treatment options have been trialled, *H. pylor*i testing can be considered or refer the patient to secondary care.

Red flags in patients presenting with dyspepsia

A patient with any of the following factors has an increased risk of significant complications and may require referral for endoscopy:[17, 18]

- Age ≥ 55 years at first presentation of new-onset dyspepsia (ten years earlier for Māori, Pacific or Asian patients*)
- Family history of gastric cancer with age of onset < 50 years
- Symptoms and signs of gastrointestinal bleeding, such as haematemesis, anaemia or melaena
- Iron-deficiency anaemia, without obvious cause, e.g. menorrhagia
- Difficulty swallowing
- Palpable abdominal mass
- Unexplained weight loss

* There is no New Zealand guideline that specifically states this age, however, it is known that Māori are disproportionately affected by gastric cancer, and at a younger age.[9] The New Zealand Management of Dyspepsia and Heartburn guidelines, 2004, are now out of date, but they recommended earlier referral for endoscopy for Māori, Pacific or Asian patients as gastric cancer presents ten years earlier in these groups.[19]

Faecal antigen testing is recommended to detect *H. pylori* infection

Faecal antigen testing is the recommended non-invasive test for *H. pylori* infection in New Zealand.[21] Faecal antigen testing can be used to diagnose active infection with *H. pylori* and, if required, to confirm that eradication treatment has been successful.[1] This technique has a reported sensitivity of 94% and specificity of 97%.[1] False negative results can occur if the patient has been taking medicines that decrease the load of *H. pylori* in the stomach, e.g. antibiotics, or the contents of the stomach are less acidic, e.g. if a patient has been taking a PPI.[1]

Practice point: Patients should be advised not to take PPIs within two weeks, or antibiotics or bismuth compounds (found in some indigestion remedies) within four weeks prior to faecal antigen testing to prevent false negative results.[2, 17]

Serum antibody testing (serology) for *H. pylori* has previously been recommended as the most appropriate diagnostic test in New Zealand. However, with the improved availability and accuracy of faecal antigen tests, serology is no longer preferred.[21] Serology cannot distinguish between infection that is past or current, and because antibody levels decrease slowly over 6 – 12 months or longer after eradication treatment, it cannot be used as a test of treatment success.[1, 19]

Carbon-13 urea breath testing is still regarded in the literature as the gold standard for clinical diagnosis of *H. pylori* infection.[1, 22] However, this test has limited availability in New Zealand due in part to the specialist laboratory equipment and training required. Both the sensitivity and specificity for carbon-13 urea breath testing is reported to be comparable to faecal antigen testing.[2, 22]

Invasive testing is reserved for patients with dyspepsia and red flag symptoms

Patients presenting with red flag symptoms may require more invasive testing, e.g. endoscopy, to identify or rule out malignancy. It may be appropriate to prescribe a PPI and request a faecal antigen test while patients are waiting for endoscopy. Regional HealthPathways guidance suggests lower thresholds for endoscopy referral in patients who present with dyspeptic symptoms and have a previous history of peptic ulcer disease, family history of early onset gastric cancer, i.e. relatives aged < 50 years, or significant ongoing symptoms unresponsive to treatment. Endoscopy can also provide biopsy material for histology, rapid urease testing and cultures used to detect or confirm *H. pylori* infection.[2]

Eradication treatment for *H. pylori* infection

If *H. pylori* infection is confirmed, the patient should be prescribed eradication treatment. In New Zealand, the first-line option is a **triple treatment regimen** of a PPI (usually omeprazole, but other PPIs can be used), clarithromycin and either amoxicillin or metronidazole (Table 1).[20] This combination is consistent with international guidelines and shown to be 70 – 85% effective.[10, 23, 24]

Treatment duration is 7 – 14 days. Seven-days has previously been recommended as the standard duration for the triple treatment regimen but recent international guidelines support a longer treatment period, e.g. 14 days in areas with a higher prevalence of clarithromycin-resistant *H. pylori*, including New Zealand.[2, 25]

Consider previous antibiotic exposure. Research suggests any previous lifetime exposure to any macrolide antibiotic* (due to cross-resistance) or metronidazole increases the risk for antibiotic resistance and *H. pylori* treatment failure.[26, 27] Therefore, a history of exposure to these medicines in patients with confirmed *H. pylori* infection should influence treatment decisions (see Table 1 for recommendations). In practice, it can be difficult to establish previous use of specific antibiotics from patient history or clinical notes, especially if there has been considerable period since exposure.

* Commonly used macrolides include erythromycin, roxithromycin, azithromycin and clarithromycin [20]

For further information on dosing, see: **www.nzf.org.nz/nzf_732**

Confirmation of *H. pylori* eradication is not usually required

Retesting of patients following a triple treatment regimen is not required in most cases, e.g. if symptoms have resolved.[10, 24] Faecal antigen testing is appropriate when considering second-line treatment in patients who have remained symptomatic following an initial triple treatment regimen, or to confirm treatment success in patients with peptic ulcer complications or other significant gastric conditions.[2, 20, 24]

It is generally recommended that follow-up testing occurs no sooner than three months after treatment has ceased.[1] Patients should be advised not to take PPIs within two weeks of testing, or antibiotics or bismuth compounds within four weeks of testing, to prevent false negative results.[2, 17]

When to consider second-line treatment

Expert advice: *"Consideration should be given to not proceeding with further treatment if risks outweigh benefits, particularly if it seems likely that the symptoms are unrelated to the infection"*

If first-line treatment for *H. pylori* is unsuccessful, consider the risks and benefits of escalating treatment. There may not always be a strong correlation between dyspepsia and a diagnosis of *H. pylori* and good results with treatment. In some patients, escalation of the PPI dose does not reduce symptoms and there may need to be more emphasis on lifestyle changes and stress management. In addition, patients who experienced adverse effects associated with *H. pylori* eradication treatment may be reluctant to consider further eradication treatment and, on top of already complicated treatment regimens, are at increased risk of non-adherence.[29]

Table 1. First-line *H. pylori* eradication dosing regimen.[10, 20, 24]

First-line treatment: 7 – 14 days	▪ Omeprazole, 20 mg twice daily; **and** ▪ Clarithromycin, 500 mg twice daily; **and** ▪ Amoxicillin, 1,000 mg twice daily; **or** Metronidazole, 400 mg twice daily
If previous exposure to:	**Recommendation:**
▪ Any macrolide antibiotic	▪ Prescribe omeprazole + amoxicillin + metronidazole (dosing as above)
▪ Metronidazole	▪ Prescribe omeprazole + amoxicillin + clarithromycin (dosing as above)
▪ Both macrolide antibiotics and metronidazole	▪ Discuss options with a gastroenterologist, clinical microbiologist or infectious disease specialist

Recurrence of *H. pylori* following treatment can be divided into recrudescence and reinfection.[30] Recrudescence is the temporary suppression and then reemergence, rather than successful treatment of the original *H. pylori* strain.[30] This may be related to ineffective treatment regimens and reflects most incidences of *H. pylori* recurrence.[30] Reinfection with a new *H. pylori* organism after successful treatment is rare in developed countries and likely to involve re-exposure via close contacts who have not received eradication treatment.[30]

If testing confirms that *H. pylori* is still present three months or more since treatment, and the patient remains symptomatic, a second course of treatment can be considered, using a different regimen. Alternatively, referral for endoscopy may be considered.[10, 20, 24]

The second-line regimen. International guidelines vary in their recommendations for second-line treatment regimens; these are often based on evidence specific to local populations and may be influenced by medicine availability.[31] In New Zealand, the second-line option is a two-week quadruple regimen of a PPI, e.g. omeprazole, tripotassium dicitratobismuthate (bismuth), tetracycline and metronidazole (Table 2).[20] Doxycycline is not recommended as an alternative tetracycline as it results in lower eradication rates for *H. pylori*.[7]

N.B. Levofloxacin is included in some second or third-line eradication regimens in international guidance. In New Zealand it is an unapproved, unfunded medicine, with limited availability. If levofloxacin can be procured (under Section 29), it can be combined with omeprazole and amoxicillin in a 14-day regimen.[20]

Table 2. Second-line *H. pylori* eradication dosing regimen.[10, 20, 24]

Second-line treatment: 14 days	■ Omeprazole, 20 mg twice daily; **and** ■ Tripotassium dicitratobismuthate (bismuth)*, 120 mg four times daily; **and** ■ Tetracycline†, 500 mg four times daily; **and** ■ Metronidazole, 400 mg three times daily

* Tripotassium dicitratobismuthate (colloidal bismuth sub citrate; funded) is an unapproved medicine, supplied under Section 29

† Tetracycline hydrochloride is funded with Special Authority approval when prescribed as part of the *H. pylori* quadruple treatment regimen and first-line treatment has not been successful. It is an unapproved medicine, supplied under Section 29.

H. pylori antibiotic resistance is rising

Globally, there are concerns regarding increasing resistance of *H. pylori* to standard antibiotic treatments.[25, 32] A recent meta-analysis of data from 65 countries found rates of both primary and secondary resistance of *H. pylori* to clarithromycin, metronidazole and levofloxacin, to be > 15%.[32] A 2013 New Zealand study found resistance to clarithromycin had doubled since 1999.[7] Rates of clarithromycin resistance varied with ethnicity; no resistance was reported in New Zealand Europeans while a rate of 25% was reported in Māori.[7] Potential causes for increases in *H. pylori* antibiotic resistance include inappropriate prescribing of antibiotics used in eradication regimens, lack of adherence to medicine regimens, cross resistance between other previously prescribed macrolide antibiotics, low-grade antibiotic exposure through consumption of food products from treated livestock and immigration from areas of historically high prevalence of antibiotic resistant *H. pylori*.[25, 33, 34] This highlights the importance of assessing a patient's antibiotic history, if possible, before deciding on what medicines to prescribe.

Clinician's Notepad: *H. pylori*

Patient presenting with dyspepsia-like symptoms

- Consider whether red flags are present that may indicate the need for referral for further investigation:
  - Age ≥ 55 years at first presentation of new-onset dyspepsia (ten years earlier for Māori, Pacific or Asian patients)
  - Family history of gastric cancer with age of onset < 50 years
  - Symptoms and signs of gastrointestinal bleeding, such as haematemesis, anaemia or melaena
  - Iron-deficiency anaemia, without obvious cause, e.g. menorrhagia
  - Difficulty swallowing
  - Palpable abdominal mass
  - Unexplained weight loss
- Recommend lifestyle changes, e.g. reducing meal size, avoiding large meals before bedtime, limiting alcohol intake, avoiding trigger foods, weight loss
- Trial a proton pump inhibitor (PPI), e.g. 20 mg omeprazole once daily, for four to eight weeks

If symptoms do not improve after a PPI trial

- Consider the risk of *H. pylori* infection. Factors influencing risk include geographic location (the prevalence is generally higher in Northland and Auckland regions), being of Māori, Pacific or Asian ethnicity, or having been born in a country with high rates of *H. pylori* infection
- If patients are considered to be at:
  - **High-risk of *H. pylori* infection**, request faecal antigen testing (stop PPI for two weeks before the test)
  - **Low-risk of *H. pylori* infection**, continue PPI treatment and investigate other potential causes. If none can be found or symptoms still do not resolve after alternative treatment options have been trialed or with continued PPI use, *H. pylori* testing can be considered, or refer patient to secondary care.

In patients with a confirmed *H. pylori* infection

- Prescribe first-line triple treatment (eradication) regimen for 7 – 14 days, consisting of a PPI (e.g. omeprazole, 20 mg twice daily); **and** clarithromycin (500 mg twice daily); **and** amoxicillin (1,000 mg twice daily) **or** metronidazole (400 mg twice daily)
- N.B. Consider previous antibiotic exposure before prescribing. If prior exposure to:
  - Any macrolide antibiotic – prescribe omeprazole + amoxicillin + metronidazole (dosing as above)
  - Metronidazole – prescribe omeprazole + amoxicillin + clarithromycin (dosing as above)
  - Both macrolide antibiotics and metronidazole – discuss options with a gastroenterologist, clinical microbiologist or infectious disease specialist
- Confirmation of eradication is not usually required if symptoms resolve

If symptoms remain following first-line treatment:

- Re-test for *H. pylori* infection three months later
- If the test is still positive, consider whether the potential benefits of further antibiotic treatment outweigh the risks
- If a decision is made to provide further antibiotic treatment, prescribe a 14 day second-line regimen including a PPI (e.g. omeprazole, 20 mg twice daily); **and** tripotassium dicitratobismuthate (bismuth; 120 mg four times daily); **and** tetracycline (500 mg four times daily); **and** metronidazole (400 mg three times daily)

If symptoms remain following second-line treatment, or if second-line treatment is not undertaken for any reason despite continuing symptoms/infection, consider referral to a gastroenterologist.

Acknowledgement: Thank you to **Associate Professor Alan Fraser**, Consultant Gastroenterologist, Auckland and Honorary Associate Professor of Medicine, University of Auckland, for expert review of this article.

N.B. Expert reviewers do not write the articles and are not responsible for the final content. bpac^{nz} retains editorial oversight of all content.

References

1. Sabbagh P, Mohammadnia-Afrouzi M, Javanian M, *et al*. Diagnostic methods for *Helicobacter pylori* infection: ideals, options, and limitations. Eur J Clin Microbiol Infect Dis 2019;38:55–66. doi:10.1007/s10096-018-3414-4.
2. World Gastroenterology Organisation Global Guidelines. *Helicobacter pylori*. 2021. Available from: https://www.worldgastroenterology.org/UserFiles/file/guidelines/helicobacter-pylori-english-2021.pdf (Accessed Jul, 2022).
3. Bravo D, Hoare A, Soto C, *et al*. *Helicobacter pylori* in human health and disease: mechanisms for local gastric and systemic effects. World J Gastroenterol 2018;24:3071–89. doi:10.3748/wjg.v24.i28.3071.
4. Sharndama HC, Mba IE. *Helicobacter pylori:* an up-to-date overview on the virulence and pathogenesis mechanisms. Braz J Microbiol 2022;53:33–50. doi:10.1007/s42770-021-00675-0.
5. McDonald AM, Sarfati D, Baker MG, *et al*. Trends in *Helicobacter pylori* infection among Māori, Pacific, and European birth cohorts in New Zealand. Helicobacter 2014;20:139–45. doi:10.1111/hel.12186.
6. Hooi JKY, Lai WY, Ng WK, *et al*. Global prevalence of *Helicobacter pylori* infection: systematic review and meta-analysis. Gastroenterology 2017;153:420–9. doi:10.1053/j.gastro.2017.04.022.
7. Hsiang J, Selvaratnam S, Taylor S, *et al*. Increasing primary antibiotic resistance and ethnic differences in eradication rates of *Helicobacter pylori* infection in New Zealand--a new look at an old enemy. N Z Med J 2013;126:64–76.
8. Te Aho O Te Kahu Cancer Control Agency. Pūrongo ārai mate pukupuku. Cancer Prevention Report. 2022. Available from: https://hcmsitesstorage.blob.core.windows.net/cca/assets/Cancer_Prevention_V12_7_April22_05c46c078b.pdf (Accessed May, 2022).
9. Ellison-Loschmann L, Sporle A, Corbin M, *et al*. Risk of stomach cancer in Aotearoa/New Zealand: a Māori population based case-control study. PLOS ONE 2017;12:e0181581. doi:10.1371/journal.pone.0181581.
10. National Institute for Health Care Excellence (NICE). Gastro-oesophageal reflux disease and dyspepsia in adults: investigation and management. 2014. Available from: https://www.nice.org.uk/Guidance/CG184 (Accessed Jul, 2022).
11. Chey WD, Leontiadis GI, Howden CW, *et al*. ACG clinical guideline: treatment of *Helicobacter pylori* infection. Am J Gastroenterol 2017;112:212–39. doi:10.1038/ajg.2016.563.
12. Liou J-M, Malfertheiner P, Lee Y-C, *et al*. Screening and eradication of *Helicobacter pylori* for gastric cancer prevention: the Taipei global consensus. Gut 2020;69:2093–112. doi:10.1136/gutjnl-2020-322368.
13. Pesce M, Cargiolli M, Cassarano S, *et al*. Diet and functional dyspepsia: clinical correlates and therapeutic perspectives. World J Gastroenterol 2020;26:456–65. doi:10.3748/wjg.v26.i5.456.
14. Sayuk GS, Gyawali CP. Functional dyspepsia: diagnostic and therapeutic approaches. Drugs 2020;80:1319–36. doi:10.1007/s40265-020-01362-4.
15. Rodrigues DM, Motomura DI, Tripp DA, *et al*. Are psychological interventions effective in treating functional dyspepsia? A systematic review and meta-analysis. J Gastroenterol Hepatol 2021;36:2047–57. doi:10.1111/jgh.15566.
16. Fiorini G, Saracino IM, Zullo A, *et al*. Antibiotic resistance and therapy for *H. pylori* infection in immigrant patients treated in Italy. J Clin Med 2020;9:1299. doi:10.3390/jcm9051299.
17. Malfertheiner P, Megraud F, O'Morain CA, *et al*. Management of *Helicobacter pylori* infection—the Maastricht V/Florence consensus report. Gut 2017;66:6–30. doi:10.1136/gutjnl-2016-312288.
18. National Institute for Health and Care Excellence (NICE). Suspected cancer: recognition and referral. 2015. Available from: https://www.nice.org.uk/guidance/ng12 (Accessed Jul, 2022).
19. New Zealand Guidelines Group (NZGG). Management of dyspepsia and heartburn. Evidence-based best practice guideline summary. 2004. Available from: https://www.health.govt.nz/system/files/documents/publications/dyspepsia_summary.pdf (Accessed Jul, 2022).
20. New Zealand Formulary (NZF). NZF v121. 2022. Available from: https://www.nzf.org.nz/nzf_1 (Accessed Jul, 2022).
21. Upton A. Discontinuation of *Helicobacter pylori* serology. 2020. Available from: https://fl-healthscope-media.s3.amazonaws.com/lab-sites/uploads/2020/07/H.-Pylori-Service-Update-July-2020.docx.pdf (Accessed Jul, 2022).
22. Patel SK, Pratap CB, Jain AK, *et al*. Diagnosis of *Helicobacter pylori*: what should be the gold standard? World J Gastroenterol 2014;20:12847. doi:10.3748/wjg.v20.i36.12847.
23. Yaxley J, Chakravarty B. *Helicobacter pylori* eradication - an update on the latest therapies. Aust Fam Physician 2014;43:301–5.
24. Public Health England (PHE). Test and treat for *Helicobacter pylori* (HP) in dyspepsia. Quick reference guide for primary care: For consultation and local adaptation. 2016. Available from: https://www.gov.uk/government/publications/helicobacter-pylori-diagnosis-and-treatment (Accessed Jul, 2022).
25. Schubert JP, Gehlert J, Rayner CK, *et al*. Antibiotic resistance of *Helicobacter pylori* in Australia and New Zealand: a systematic review and meta-analysis. J Gastroenterol Hepatol 2021;36:1450–6. doi:10.1111/jgh.15352.
26. Lee GH, Lee KM, Shin SJ, *et al*. Impact of previous metronidazole exposure on metronidazole-based second-line quadruple therapy for *Helicobacter pylori* infection. Korean J Intern Med 2020;35:1094–103. doi:10.3904/kjim.2020.174.
27. Guo C-G, Jiang F, Cheung KS, *et al*. Timing of prior exposure to antibiotics and failure of *Helicobacter pylori* eradication: a population-based study. J Antimicrob Chemother 2022;77:517–23. doi:10.1093/jac/dkab415.
28. Boltin D, Levi Z, Gingold-Belfer R, *et al*. Impact of previous exposure to macrolide antibiotics on *Helicobacter pylori* infection treatment outcomes. Am J Gastroenterol 2019;114:900–6. doi:10.14309/ajg.0000000000000223.
29. Ayala G, Escobedo-Hinojos WI, de la Cruz-Herrera CF, *et al*. Exploring alternative treatments for *Helicobacter pylori* infection. World J Gastroenterol 2014;20:1450. doi:10.3748/wjg.v20.i6.1450.
30. Kayali S, Manfredi M, Gaiani F, et al. *Helicobacter pylori*, transmission routes and recurrence of infection: state of the art. Acta Biomed 2018;89:72–6. doi:10.23750/abm.v89i8-S.7947.
31. Shah SC, Iyer PG, Moss SF. AGA clinical practice update on the management of refractory *Helicobacter pylori* infection: expert review. Gastroenterology 2021;160:1831–41. doi:10.1053/j.gastro.2020.11.059
32. Savoldi A, Carrara E, Graham DY, *et al*. Prevalence of antibiotic resistance in *Helicobacter pylori*: a systematic review and meta-analysis in World Health Organization regions. Gastroenterology 2018;155:1372-1382.e17. doi:10.1053/j.gastro.2018.07.007.
33. Shahbazi S, Vahdat Shariatpanahi Z. Comparison between daily single-dose triple therapy and conventional triple therapy on patient compliance and *Helicobacter pylori* eradication: a randomized controlled trial. Indian J Gastroenterol 2018;37:550–4. doi:10.1007/s12664-018-0916-z.
34. Kuo Y-T, Liou J-M, El-Omar EM, *et al*. Primary antibiotic resistance in *Helicobacter pylori* in the Asia-Pacific region: a systematic review and meta-analysis. Lancet Gastroenterol Hepatol 2017;2:707–15. doi:10.1016/S2468-1253(17)30219-4.

This article is available online at:
www.bpac.org.nz/2022/h-pylori.aspx