

Prevalence and eradication efficacy of *Helicobacter pylori* infection in children in the Mekong delta, Vietnam: a cross-sectional study

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Abstract

Background: Worldwide, *Helicobacter pylori* (HP) infection in children with peptic ulcer and/or gastritis (PUG) is increasingly common. In Vietnam, clinical symptoms of HP infection in PUG children are often non-specific, and treatment regimens currently have a low success rate.

Objective: This study determined the HP infection prevalence, its clinical and endoscopic findings, and its associated factors. Additionally, the efficiencies of HP treatment regimens in PUG children were also evaluated.

Design and setting: A cross-sectional descriptive study was conducted on 140 pediatric patients diagnosed with PUG at Can Tho Children's Hospital from 2017–2019.

Results: The prevalence of HP infection in PUG children was 46.4%. A significant association was found between HP infection and patient possessing a family history of HP infection (aOR: 2.35 (1.1–4.76)). Symptoms of abdominal pain accounted for the highest rate of 88.6%, followed by vomiting, heartburn, epigastric burning, and gastric bleeding (57.9%, 36.4%, 22.9%, and 13.6%, respectively). Endoscopic findings denoted that inflammatory lesions accounted for 85% and ulcers accounted for 15%. The successful HP eradication rate using the PAM regimen (Proton pump inhibitor/amoxicillin/metronidazole) was 51.8%, with 13.6% of PUG children encountering side effects.

Conclusion: PUG children have a high rate of HP infection. Clinical symptoms are often non-specific, in which abdominal pain is the most common symptom. The success of HP eradication by the standard guideline of the Vietnam Ministry of Health is quite low. Thus, critical adjustments in the regimens are necessary.

Keywords

Helicobacter pylori, inflammation, children, peptic ulcer, PAM

Introduction

Peptic ulcer and/or gastritis (PUG) disease is increasingly more popular in children around the world. *Helicobacter pylori* (HP) infection has been considered the major cause of PUG in children. In developed nations, the prevalence rates of HP infection among children range from as low as 1.8% to as high as 65% (Aitila et al. 2019). On the other hand, in developing countries, these rates are generally higher, reaching up to 90% in some countries (Aitila et al. 2019). In Vietnam, although limited information has been published regarding the nationwide HP infection prevalence, research has found that this number was somehow moderate in specific cities/provinces such as Dien Bien (42.8%) and Tra Vinh (32.1%) (Nguyen 2016a). Moreover, clinical symptoms of PUG caused by HP infection are non-specific, thus, this disease is often misdiagnosed. A study reported that in Vietnam, 97.5% of PUG children had abdominal pain, in which the pain duration of more than 3 months accounted for 92.7%. Other symptoms such as anorexia, vomiting, indigestion, heartburn were much fewer (Tang et al. 2018a). Additionally, paraclinical investigation of endoscopy also demonstrated variations in PUG children with HP infection. PUG children with antral nodularity were 12.86 times more likely to have HP infection compared with children without antral nodularity, and children with HP infection had antral nodularity higher than the other ($p < 0.05$) (Hasosah et al. 2015). The sensitivity of the nodularity presence as an indicator of HP infection was 91.6%, with a specificity of 91%, a positive predictive value of 81%, and a negative predictive value of 96% (Azowska-Przeorek et al. 2015).

Regarding the HP infection treatment regimens in PUG children, in Japan, the HP eradication rates were 60.5% for PAC regimen (Proton Pump inhibitor (PPI)/amoxicillin/clarithromycin) and 98.3% for PAM regimen (PPI/amoxicillin/metronidazole). Thus, PAM is selected as the first-line treatment for young people with HP infection if an antibiotic susceptibility test could not be performed (Mabe et al. 2018). Nevertheless, in countries with high rates of drug-resistant HP such as Vietnam, the effectiveness of these standard regimens is questionable. For instance, in Vietnam, the PAC regimen was only effective in 32.1% of the HP infection cases (Nguyen 2016b). Similarly, the HP eradication in PUG children utilizing a 3-drug regimen consisting of a combination of two antibiotics and a PPI had only 49% success rate (Le 2014; Nguyen 2014). Moreover, although various research has been conducted in Vietnam (i.e., Ha Noi (Nguyen 2016b), Hue (Pham et al. 2018), and Tay Nguyen area (Le 2014) on this issue, no data is available in the Mekong Delta, the largest area in the South of Vietnam, with a population of approximately 20 million people (18% of the Vietnam population).

To this end, this present study investigated the prevalence and treatment efficiency of HP infection in PUG children in the Mekong Delta, Vietnam. The work also compared the rate of clinical signs and endoscopy findings

between PUG children with HP (+) and HP (-). Additionally, the HP eradication rate in PUG children of the standard PAM regimen, issued by the Vietnam Ministry of Health, has been determined and discussed.

Materials and methods

Study design

Cross-sectional descriptive design was employed in this study. The research was conducted on 140 PUG children in the Mekong Delta, Vietnam, from April 2017 to April 2019. The patient was included when he/she had all three inclusion criteria of (1) clinically, the child has one or more PUG symptoms of recurrent abdominal pain (> 3 times within 3 months), vomiting, nausea, indigestion, heartburn, gastric bleeding, black stools/vomiting blood, and iron deficiency anemia with unknown cause; (2) paraclinically, the gastro-duodenal endoscopy results with inflammatory lesions and/or peptic ulcers; and (3) family and patient consent to participate in the study. The exclusion criteria included (1) patients treated with antibiotics, antacids, and PPI in the previous 4 weeks; (2) patients possessed known allergy to one of the study medications; and (3) patients having acute heart, liver, or kidney failure.

HP diagnosis

HP infection was diagnosed by using two tests of (1) urease test and (2) stool antigen test (SAT) or urease breath test (UBT). The patients were categorized into two groups, including the HP (+) group, which represents patients who were both positive with urease test and SAT/UBT, and the HP (-) group, representing patients who had a negative result in one of the tests.

The PUG clinical symptoms were collected through clinical examination and questioning, including localized symptoms of the digestive tract (abdominal pain, vomiting, eructation, heartburn, and gastric bleeding). Endoscopy investigations in PUG children were determined and classified following the Sydney system (Erythematous/exudative; Flat erosive; Raised erosive; Nodular; Enterogastric reflux; Hemorrhagic; and Hypertrophy of the gastric mucosa) (Dixon et al. 1996). Additionally, the gastritis levels were also separated into different categories of mild (small visible vessels), moderate (visible vascular network), and severe (distinct, prominent vascular network). PUG children were then be divided according to the number of ulcers (1 foci, ≥ 2 foci) and the ulcer size (≥ 1 cm, < 1 cm).

HP treatment

The PAM regimen, the standard treatment for HP infection issued by the Vietnam Ministry of Health, was selected in the study. This includes amoxicillin (50 mg/kg/day,

maximum 2 g/day, twice daily), metronidazole (20 mg/kg/day, maximum 500 mg/day, twice daily), and a PPI (esomeprazole or omeprazole 1 mg/kg/day, maximum 20 mg/day) for 2 weeks. Then, PPI was continued to suppress gastric acid secretion for another 6–8 weeks to heal the damage in the gastrointestinal tract.

The treated PUG children were follow-up at 3 times points, including (1) first time, one week after the onset of the PAM regimen, to evaluate the treatment efficiency and monitor drug side effects; (2) second time, after the completion of the PAM regimen (2 weeks), to re-evaluate the treatment efficiency and monitor drug side effects, continue to maintain the inhibition of gastric acid secretion to heal gastro-duodenal lesions; and (3) third time, after the patient has stopped antibiotics for ≥ 4 weeks and suppressed gastric acid secretion for 2 weeks, to evaluate the HP eradication by SAT/UBT, and observe the improvement in clinical symptoms of pediatric patients.

The results of HP eradication after using the treatment regimen are assessed by either breath test (if HP infection was previously diagnosed by urease test and breath test) or stool test (if HP infection was diagnosed by urease test and stool test). The treatment was considered successful when the breath test or stool test shows negative results. Other cases were deemed unsuccessful.

Statistical analysis

Statistical analysis was carried out utilizing the SPSS 18.0 program. The Chi-squared test (or Fisher's exact test) was used to compute the correlations between variables. Variables with a test results of $p < 0.05$ will be analyzed in the multivariable regression model. A p -value of < 0.05 was considered significant.

Results

Prevalence of HP infection

Table 1 describes the study participants' characteristics. The prevalence of HP infection in PUG children was 46.4%. The infected children have an average age of 10.88 ± 2.6 years old. Most children participating in the

Table 1. Characteristics of participants (n = 140). HP: *Helicobacter pylori*.

Variable	Number (n)	Percentage (%)	
		Number (n)	Percentage (%)
Age	6-<11	68	48.6
	11–15	72	51.4
Gender	Male	67	47.9
	Female	73	52.1
Living area	Urban	82	58.6
	Rural	58	41.4
Ethnic group	Kinh	135	96.4
	Other	5	3.6
Family economy	Wealthy	101	72.1
	Average – Poor	39	27.9
Family history of HP infection	Yes	68	48.6
	No	72	51.4
HP infections	Yes	65	46.4
	No	75	53.6

study lived in urban areas (58.6%) and belonged to the Kinh ethnic group (96.4%) and wealthy families (72.1%).

The χ^2 test showed that there was a relationship between the prevalence of HP infection in PUG children and the children living area ($p = 0.006$), family economy ($p = 0.02$), and family history of HP infection ($p = 0.004$) (Table 2). To this end, pediatric patients living in urban areas would have a 2.62 times higher rate of HP infection than children living in rural areas. The prevalence of HP infection in children with a wealthy family was 2.48 times higher than that of the children with average/poor economic families. Additionally, children with a family history of HP infection had a 2.68 times higher rate of HP infection for themselves than the other group. Nevertheless, multivariable logistic regression analysis demonstrates that only the relationship between family history of HP infection and the HP infection status in children was statistically significant ($p = 0.018$).

Clinical and paraclinical characteristics

In terms of the clinical and paraclinical characteristics (Table 3), abdominal pain was the highest clinical symptom presented in PUG children (88.6%). According to the χ^2 test, children without abdominal pain possessed a higher rate of HP infection than those with abdominal pain. In addition, children with eructation had a higher rate of HP infection than the other group. Regarding

Table 2. Associations between participants' sociodemographic characteristics and *Helicobacter pylori* (HP) infection (n = 140).

		HP infection, n (%)		Total	Univariate analysis		Multivariate analysis	
		Yes	No		p	OR (CI 95%)	p	aOR
Age	6-<11	29 (42.6)	39 (57.4)	68 (48.6)	0.38	0.74 (0.38–1.4)	–	–
	11–15	36 (50.0)	36 (50.0)	72 (51.4)		1	–	–
Gender	Male	33 (49.3)	34 (50.7)	67 (47.9)	0.52	1.24 (0.6–2.4)	–	–
	Female	32 (43.8)	41 (56.2)	73 (52.1)		1	–	–
Living area	Urban	46 (58.6)	36 (41.4)	82 (58.6)	0.006	2.62 (1.3–5.2)	0.057	2.07 (0.9–4.3)
	Rural	19 (32.8)	39 (67.2)	58 (41.4)		1		1
Family economy	Wealthy	53 (52.5)	48 (47.5)	101 (72.1)	0.020	2.48 (1.1–5.4)	0.19	1.75 (0.7–4)
	Average – Poor	12 (30.8)	27 (69.2)	39 (27.9)		1		1
Family history of HP infection	Yes	40 (58.8)	28 (41.2)	68 (48.6)	0.004	2.68 (1.3–5.3)	0.018	2.35 (1.1–4.76)
	No	25 (34.7)	47 (65.3)	72 (51.4)		1		1

the endoscopy findings, we recorded 21 cases of peptic ulcers (15%) and 119 cases of gastritis (85%). The rate of HP infection in the peptic ulcers group (81%) was statistically ($p < 0.05$) higher than that of the gastritis group (40.3%).

Treatment outcome

For the PAM treatment outcome, our study recorded 65 PUG children with HP infection that were admitted to the standard treatment. For this, 9 children were excluded from the study population due to treatment abandonment and loss of track. Thus, the results were analyzed on 56 participants. The success rate of treating HP with the standard PAM regimen was only 51.8% (Table 4). There were 13 cases (23.3%) where patients reported suffering from side effects during treatment. Among them, the common side effects were diarrhea (8 cases), vomiting (4 cases), and anorexia (1 case). Most patients after completing the treatment process had improved clinical symptoms (Table 4). The rate of clinical

symptom improvement of abdominal pain, anorexia, vomiting, eructation, and heartburn was 69.6%, 87.0%, 82.4%, 73.3%, and 83.3%, respectively.

Discussion

Prevalence of HP infection

In our study, the rate of PUG children with HP infection in the Mekong Delta, Vietnam was 46.4%. This number was in accordance with previous reports in other areas/cities/provinces in Vietnam. For instance, the prevalence of HP infection in children in Lang Son was 41.4% in 2016 (Nguyen 2016c), in Dien Bien was 42.8% (Nguyen 2016a). Nevertheless, a high rate of HP infection was reported in Hue (76.4%) (Pham et al. 2018). In general, the prevalence of HP infection in Vietnamese children was higher than the world (33.3%) and other developed Asian countries' average rate (Okuda et al. 2019a). In Hangzhou, China, the overall HP infection rate was 18.6% (Shu et al. 2017), whereas in Japan, the prevalence of HP infection in children accounts for only 4.8% (Nakayama et al. 2017). This can be explained because of the Vietnamese culture of using chopsticks to pick up food together, sharing food dishes and dipping cups, and chewing rice for children (i.e., mouth-to-mouth eating habit), to name a few. These traditions have increased the HP infection status of the community (Okuda et al. 2019a), which consequently reflects the high prevalence of HP infection in PUG children.

Regarding the associated factors, children with a family history of HP infection had a 2.35-times higher rate of HP infection than the other group ($p < 0.05$), similar to the previous studies (Hososah et al. 2015; Shu et al. 2017). In Dien Bien, children whose mother got infected with HP had 1.59-times higher risk than others ($p < 0.05$) (Nguyen 2016a). Moreover, in Vietnam, children who were born to HP (+) mothers possessed an increased risk of HP infection by 4.4 times ($p < 0.01$) (Nguyen et al. 2016c). In the study of Dao Viet Hang et

Table 3. Clinical features and endoscopy findings in PUG children with/without *Helicobacter pylori* (HP) infection (n = 140).

		Total n (%)	HP (+) n (%)	HP (-) n (%)	p
Symptoms of the digestive tract					
Abdominal pain	Yes	124 (88.6)	53 (42.7)	71 (57.3)	0.01
	No	16 (11.4)	12 (75.0)	4 (25.0)	
Eructation	Yes	51 (36.4)	32 (62.7)	19 (37.3)	0.003
	No	89 (63.6)	33 (37.1)	56 (62.9)	
Vomiting	Yes	81 (57.9)	39 (48.1)	42 (51.9)	0.6
	No	59 (42.1)	26 (44.0)	33 (56.0)	
Heartburn	Yes	15 (23.1)	17 (34.7)	32 (65.3)	0.95
	No	50 (76.9)	58 (85.3)	108 (14.7)	
Gastric bleeding	Yes	19 (13.6)	11 (57.9)	8 (42.1)	0.28
	No	121(86.4)	54 (44.6)	67 (55.3)	
Endoscopic lesions (n = 140)					
	Ulcerative lesion(s)	21 (15.0)	17 (81.0)	4 (19.0)	0.001*
	Inflammatory lesion(s)	119 (85.0)	48 (40.3)	71 (59.7)	
Gastritis (n = 119)					
Sydney classification	Erythematous gastritis	106 (89.1)	40 (37.7)	66 (63.3)	0.070
	Flat erosive gastritis	4 (3.4)	2 (50)	2 (50)	
	Raised erosive gastritis	1 (0.8)	1 (100)	0	
	Nodular gastritis	4 (3.4)	4 (100)	0	
	Enterogastric reflux gastritis	2 (1.7)	0	2 (100)	
	Hemorrhagic gastritis	1 (0.8)	0	1 (100)	
	Gastric mucosal hypertrophy	1 (0.8)	1 (100)	0	
Gastritis grade	Moderate to severe	67 (56.3)	35 (52.2)	32 (47.8)	0.030
	Mild	52 (43.7)	13 (25)	39 (75)	
Peptic ulcers (n = 21)					
Ulcer size	≥1 cm	10 (47.6)	8 (80)	2 (20)	0.9*
	<1 cm	11 (52.4)	9 (81.8)	2 (18.2)	
Number of ulcers	≥2	7 (33.3)	5 (71.4)	2 (28.6)	0.9*
	1	14 (66.7)	12 (85.7)	2 (14.3)	

(*): Fisher's exact correction

Table 4. *Helicobacter pylori* (HP) treatment outcome (n = 56).

Treatment outcome		Number (n)	Percentage (%)
		Successful	29
	Unsuccessful	27	48.2
Side effects	Yes	13	23.2
	No	43	76.8
Symptom improvement			
Abdominal pain	Yes (no symptom)	32	69.6
	No	14	30.4
Anorexia	Yes (no symptom)	20	87.0
	No	3	13.0
Vomiting	Yes (no symptom)	28	82.4
	No	6	17.6
Eructation	Yes (no symptom)	22	73.3
	No	8	26.7
Heartburn	Yes (no symptom)	10	83.3
	No	2	16.7

al., in 2019, in households with people infected with HP, the rate of HP infection in the age group of < 8, 8–10, and 11–15 years old was 98.6%, 95.5%, and 88.5%, respectively; and up to 69.4% of households have 100% members with the disease (Dao et al. 2019). Explainably, since the main route of HP transmission from person to person is the mouth-to-mouth route, and Vietnamese people tend to eat the same food dishes, use chopsticks to pick up food for themselves and others, and women commonly chew rice to feed her child, it is easily for children to be infected with HP when their family member got previously infected.

Clinical and paraclinical characteristics

The most dominant symptoms in the gastrointestinal tract in our study was abdominal pain, accounting for 88.6%. The prevalence of HP infection in children with abdominal pain (42.7%) was lower than those with no abdominal pain (75%) ($p = 0.01$). In contrast, a study in Iran showed that children with abdominal pain had a significant higher prevalence of HP infection than the group without abdominal pain (Alimohammadi et al. 2016; Castillo-Montoya et al. 2017). Meanwhile, another report stated that no significant difference was noted between HP infection and recurrent abdominal pain (Mansour et al. 2012). Thus, the relationship between abdominal pain and HP infection is still controversial. Therefore, the evaluation of HP infection status in children with abdominal pain should be considered, even with the non-invasive test results, because this symptom could cause anxiety for children and their family (Jones et al. 2017). Regarding other symptoms, the group of children with eructation had 62.7% chance of HP infections, significantly higher ($p = 0.003$) than the group without eructation (37.1%). Moreover, the percentages of other symptoms of vomiting and heartburn in our work were greater than other studies (Nguyen 2016b; Pham et al. 2018). This could be explained by the differences in the children ages in our study (6–15 years old) and the other studies (<6 years old). Conclusively, the clinical symptoms of HP infection in PUG children are often non-specific, change with age, and are easily confused with the symptoms of other diseases.

In terms of the endoscopic findings, on 140 children, we recorded 21 children with ulcerative lesions (peptic ulcers) and 119 children with inflammatory lesions (gastritis). In the group of peptic ulcers children, up to 85% of children were infected with HP, and this rate was only 40.3% in children with inflammatory lesions on endoscopy ($p = 0.001$). These results were consistent with the literature. In the previous studies, the rate of HP infection in peptic ulcers children was 83.3%, and in children with gastritis was only 50% (Ozbey et al. 2015; Tang et al. 2018b). The Koca's group also recorded the prevalence of HP infection in the group of erosive gastritis was 20%, gastric ulcer was 40%, and duodenal ulcer was 71.5% (Koca et al. 2016). In summary, most studies show that there is a strong association between HP infection and

PUG disease. Therefore, according to the North American Society for Pediatric Gastroenterology, Hepatology & Nutrition, it is recommended to evaluate the status of HP infection in PUG children. In case of the HP (+), the child needs to be treated and evaluated the treatment outcome (Jones et al. 2017).

Treatment outcome

The rate of successful HP eradication with the 3-drug PAM regimen in our study was 51.8%. Similar results were recorded in the study of Nguyen Thi Ut et al (53.6%) (Nguyen 2016b), Nguyen Thi Viet Ha et al (66.7%) (Nguyen and Phan 2013), and Nguyen Phuc Thinh et al (36.4%) (Nguyen 2014). In general, studies in Vietnam indicate that the success rate of PAM regimen ranges from 50–70%, lower than that of other developed countries. In Slovenia, from 2011–2014, the successful rate of the PAM regimen in eradicating HP was up to 85.9% (Butenko et al. 2017). In northern Portuguese, this rate reached 97.8% in children (Sliva et al. 2018). In Japan, the successful eradication rate of HP by PAM regimen was 96.8% (Okuada et al. 2017; Mabe et al. 2018). Therefore, a 2019-report recommended using PAM regimen as a first-line choice in the eradication of HP in children in Japan (Okuda et al. 2019). One of the important reasons underlying the low efficiency of PAM regimen in Vietnamese children is the antibiotic resistance issue. In Vietnam, the prevalence of HP drug-resistant strain is accelerating (Nguyen 2021). Therefore, the success rate of HP eradication only ranges from 50–70% with the PAM regimen, and < 50% with the PAC regimen, even when the bacteria is sensitive to clarithromycin (Nguyen 2011; Le 2014; Do 2019). Recently, the role of bismuth has been increasingly confirmed to have a positive influence on the outcome of HP treatment (Casranel et al. 2018). Therefore, the European Society for Paediatric Gastroenterology Hepatology and Nutrition has recommended bismuth and high-dose amoxicillin in the treatment regimen for eradication of HP in children (Jones et al. 2017). Conclusively, Vietnam policy-makers should consider these recommendations in improving the HP treatment outcome in children.

Regarding the side effects occurring during treatment, in 56 treated children, 13 children (23.2%) possessed observable side effects. Among them, 8 (61.5%) had diarrhea, 4 (30.8%) had vomiting, and 1 (7.7%) had anorexia. Similarly, previous publications also recorded an overall side effects rate of 15.4%–21.2% (Okuda et al. 2017; Mabe et al. 2018), in which diarrhea predominated, followed by vomiting, fatigue, fever, and itching (Butenko et al. 2017). Conclusively, the incidence of side effects was low and the side effects were mild, indicating that the PAM regimen is safe to use in children. Nevertheless, in clinical practice, medical practitioners need to be considerate to clearly distinguish between the drug side effects and the gastrointestinal symptoms of the diseases.

Conclusions

The prevalence of HP infection in PUG children in the Mekong Delta was 46.4%, higher than the world average. Children with a family member infected with HP possessed a higher risk of infection. Abdominal pain was the most common gastrointestinal symptom in infected children. Symptoms in PUG children are often non-specific and vary with age. The low HP eradication success rate of the PAM regimen (51.8%) proves that the antibiotic resistance of HP in children in the Mekong Delta was high. In summary, clinicians should consider choosing an appropriate treatment regimen

based on the results of each patient's antibiogram. At the same time, policy-makers should seriously tackle the antibiotic resistance issue in Vietnam, update the first-line HP treatment regimen based on international recommendations, and propose guidelines on culinary, eating, and preserving food to avoid the mouth-to-mouth HP transmission.

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References

- Aitila P, Mutyaba M, Okeny S, Kasule MN, Kasule R, Ssedyabane F, Okongo B, Apecu RO, Muwanguzi E, Oyet C (2019) Prevalence and Risk Factors of *Helicobacter pylori* Infection among Children Aged 1 to 15 Years at Holy Innocents Children's Hospital, Mbarara, South Western Uganda. *Journal of tropical medicine* 2019: e9303072. [6 pp] <https://doi.org/10.1155/2019/9303072>
- Alimohammadi H, Fouladi N, Salehzadeh, Alipour SA, Javadi MS (2016) Childhood recurrent abdominal pain and *Helicobacter pylori* infection, Islamic Republic of Iran Eastern Mediterranean Health Journal 22: 860–864. <https://doi.org/10.26719/2016.22.12.860>
- Azowska-Przeorek I, Kotowska M, Banasiuk M, Karolewska-Bochenek K (2015) Value of Antral Nodularity for the Diagnosis of *Helicobacter pylori* Infection in Children. *Medical Science Monitor* 21: 1827–1830. <https://doi.org/10.12659/MSM.893467>
- Butenko T, Jeverica S, Orel R, Homan M (2017) Antibacterial resistance and the success of tailored triple therapy in *Helicobacter pylori* strains isolated from slovenian children. *Helicobacter* 22: 1–6. <https://doi.org/10.1111/hel.12400>
- Cadranel S, Oderda G, Koletzko S (2018) Forty Years of *Helicobacter Pylori* in ESPGHAN. *Journal of Pediatrics Gastroenterology and Nutrition* 66: 65–67. <https://doi.org/10.1097/mpg.0000000000001915>
- Castillo-Montoya V, Ruiz-Bustos E, Valencia-Juillerat ME, Alvarez GH, Norbrto SC (2017) Detection of *Helicobacter pylori* in children and adolescents using the monoclonal coproantigen immunoassay and its association with gastrointestinal diseases. *Cirugía y Cirujanos (English Edition)* 85(1): 27–33. <https://doi.org/10.1016/j.circen.2016.05.003>
- Dao VH, Vu TV, Ngo TTH, Nguyen VH, Duong VL (2019) *Helicobacter Pylori* infection status in families with H.p infected family. *Journal of Medical Research* 117: 52–60.
- Dixon MF, Genta RM, Yardley JH, Correa P (1996) Classification and grading of Gastritis: The updated Sydney system. *American Journal of surgical pathology* 20: 1161–1181. <https://doi.org/10.1097/00000478-199610000-00001>
- Do T, Nguyen TTH, Ha TN, Nguyen TN, Nguyen VL, Nguyen TTT, Pham Y (2019) Identification of Anti-*Helicobacter pylori* Compounds From *Usnea undulata*. *Natural Product Communications*: 1–3. <https://doi.org/10.1177%2F1934578X19864212>
- Hasosah M, Satti M, Shehza A, Alsahafi A, Skkar G, Alzaben A, Sunaid A, Ahmet A, Mufti A, Jaconson K (2015) Prevalence and Risk Factors of *Helicobacter pylori* Infection in Saudi Children: A Three-Year Prospective Controlled Study. *Helicobacter* 20: 56–63. <https://doi.org/10.1111/hel.12172>
- Jones LN, Koletzko S, Goodman K, Bontems P, Cadranel S, Casswall T (2017) Joint ESPGHAN/NASPGHAN guidelines for the management of *Helicobacter Pylori* in children and adolescents. *Journal of Pediatrics Gastroenterology Nutrition* 64: 991–1003. <https://doi.org/10.1097/mpg.0000000000001594>
- Koca T, Serdaroglu F, Dereci S, Akcam M (2016) Peptic Ulcers and Erosions in Children at a Pediatric Unit in Turkey. *Indian Pediatrics* 53: 692–694. <https://doi.org/10.1007/s13312-016-0912-2>
- Le T (2014) Study on epidemiological characteristics of *Helicobacter pylori* infection in children in Tay Nguyen, Vietnam. PhD thesis, Ha Noi medical university, Ha Noi, Viet Nam.
- Mabe K, Okuda M, Kikuchi S, Amagai K, Rie Y, Kato M, Sakamoto N, Asaka M (2018) Randomized controlled trial: PPI-based triple therapy containing metronidazole versus clarithromycin as first-line treatment for *Helicobacter pylori* in adolescents and young adults in Japan. *Journal of Infection and Chemotherapy* 24: 538–543. <https://doi.org/10.1016/j.jiac.2018.02.013>
- Mansour MM, AlHadidi KM, Omar MA (2012) *Helicobacter pylori* and recurrent abdominal pain in children: Is there any relation? *Tropical Gastroenterology* 33: 55–61. <https://doi.org/10.7869/tg.2012.9>
- Nakayama Y, Lin Y, Hongo M, Hidaka H, Kikuchi S (2017) *Helicobacter pylori* infection and its related factor in junior high school in Nagano Prefecture, Japan. *Helicobacter* 22: 22–26. <https://doi.org/10.1111/hel.12363>
- Nguyen CT, Pham NT, Nguyen AT (2011) *Helicobacter pylori* induced gastritis and peptic ulcer disease in children: clinical features, endoscopic findings and efficacy of OAC regimen in eradication therapy. *Ho Chi Minh City Journal of Medicine* 1: 294–301.
- Nguyen DK, Pham DT, Tee TS (2021) Antibiotic usage and resistance in animal production in Vietnam: a review of existing literature. *Tropical Animal Health and Production* 53: 340. <https://doi.org/10.1007/s11250-021-02780-6>
- Nguyen PT (2014) Study of clinical, paraclinical characteristics and treatment efficiency of peptic ulcer disease caused by *Helicobacter pylori* in children at Children's Hospital 1. Master thesis, University of medicine and pharmacy in Ho Chi Minh City, Vietnam.
- Nguyen TAX (2016a) Study on some epidemiological characteristics of *H. pylori* infection in children and household members of Thai and Khmer ethnic groups. PhD thesis, Ha Noi medical university, Ha Noi, Viet Nam.

- Nguyen TU (2016b) Epidemiological, clinical characteristics and efficacy of some regimens for the treatment of peptic ulcer and/or gastritis caused by *Helicobacter pylori* in children at the National Children's Hospital. PhD thesis, National institute of hygiene and epidemiology, Ha noi, Viet Nam.
- Nguyen TVH, Nguyen VB, Phan TTB, Ha TTH (2016c) Epidemiology of helicobacter pylori infection in Tay Children in Vietnam. *Annals of clinical and laboratory Research* 4: 1–22. <https://doi.org/10.21767/2386-5180.1000125>
- Nguyen TVH, Phan TTB (2013) The rates of metronidazole resistance in relation to treatment outcome and reinfection rate in Vietnamese children. *Journal of Practical Medicine* 8: 6–9.
- Okuda M, Kikuchi S, Mabe K, Osaki T, Kamiya S, Fukuda Y, Kato M (2017) Nationwide survey of *Helicobacter pylori* treatment for children and adolescents in Japan. *Pediatric International* 59: 57–61. <https://doi.org/10.1111/ped.13038>
- Okuda M, Lin Y, Kikuchi S (2019a) *Helicobacter pylori* Infection in children and adolescents. In: Okuda (Ed.) *Advances in Experimental Medicine and Biology*. Springer, 1–14. https://doi.org/10.1007/5584_2019_361
- Okuda M, Lin Y, Wang C, Kakiuchi T (2019b) Metronidazole for *Helicobacter pylori* eradication therapy among children and adolescents in Japan: Overcoming controversies and concerns. *Helicobacter* 24: 1–6.
- Ozbey G, Dogan Y, Demiroren K, Ozercan I (2015) Prevalence of *Helicobacter pylori* in children in eastern Turkey and molecular typing of isolates. *Brazilian Journal of Microbiology* 46: 505–511. <https://doi.org/10.1590/s1517-838246220140234>
- Pham VPT, Nguyen TC, Nguyen TTH (2018) Study on clinical and paraclinical characteristics of peptic ulcer and/or gastritis. *National Pediatric Science Conference*: 8–12.
- Shu X, Ping M, Yin G, Jiang M (2017) Investigation of *Helicobacter pylori* infection among symptomatic children in Hangzhou from 2007–2014: a retrospective study with 12,796 cases. *PeerJ* 5: e2937. <https://doi.org/10.7717/peerj.2937>
- Sliva GM, Sliva HM, Nascimento J, Goncalves JP, Pereira F, Lima R (2018) *Helicobacter pylori* antimicrobial resistance in a paediatric population. *Helicobacter* 23(5): e12528. <https://doi.org/10.1111/hel.12528>
- Tang LCN, Nguyen AT, Nguyen MN, Nguyen TT (2018a) Antibiotic resistance and effectiveness of *Helicobacter pylori* eradication in children with gastritis. *National Pediatric Science Conference* in 2018:
- Tang Z, Shi J, Ji M, Shi P, Huang Z, Huang Y (2018b) The characteristics of 83 giant peptic ulcers in Chinese children: Evaluation and follow-up. *Saudi Journal of Gastroenterol* 24: 360–364. https://doi.org/10.4103/sjg.sjg_147_18