



Review article

The role of the occupational physician in controlling gastric cancer attributable to *Helicobacter pylori* infection: A review

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ABSTRACT

This review aimed to describe the potential role of occupational physician in the implementation of a screening program for *Helicobacter pylori* (Hp) infection for gastric cancer prevention.

We reviewed the epidemiological background of gastric cancer and its association with Hp, exploring the hypothesis of a “test-and-treat” protocol among working population. Clinical trials and model-based studies were collected to provided empirical evidence of the feasibility of eradication on large scale. In particular, previous studies conducted in occupational settings were discussed.

Hp prevalence ranges between about 20 and 90%, with higher rates in Asia and Latin America and lower rates in Europe and North America. Large-scale trials on screening and treatment of infection have been conducted especially in East Asia, lacking elsewhere. Only few studies investigated Hp prevalence among workers. The benefit of eradication at occupational level has not yet been adequately studied.

The design of a workplace-based Hp screening program appears to be innovative and could contribute to controlling gastric cancer. The benefit would involve not only high-risk subjects, but also their families, since the route of transmission is principally within the household. An occupational setting for a Hp screening would have positive consequences in terms of individual and public health.

1. Introduction

Although the age-adjusted incidence rate of gastric cancer has decreased in most populations (Supplementary Fig. 1), the burden of the disease remains high (Bray et al., 2017). According to Global Burden of Disease (GBD) study, in 2017 more than 1.22 million new cases of gastric cancer were diagnosed worldwide, and close to 865,000 people died from the disease, making it the third most frequent cause of neoplastic death (The global, regional, and national burden of stomach cancer in 195 countries, 2017). In most populations gastric cancer is more frequent in men than in women: the incidence rate in the 2018 in the US was 15.7/100,000 and 7.0/100,000 respectively (Thrift and El-Serag, 2020). The incidence is higher in less-developed countries and in the least affluent groups of the population.

Survival has only modestly improved in many countries over the last decades; 5-year survival ranges from 65 to 70% in countries in which imaging-based screening is implemented, such as Japan and South

Korea, to 15–30% in US and Europe. The high fatality rates are explained by the fact that, despite a long latency, gastric cancer is usually diagnosed at late stage, when prognosis is poor.

Gastric cancer can be distinguished by subsite into cardia and non-cardia type (Boffetta et al., 2014), the latter mainly caused by infection with *Helicobacter pylori* (Hp) (Marshall and Warren, 1984). Other environmental and genetic risk factors have been identified: they are summarized in Table 1 (Boffetta et al., 2014).

Hp infection typically occurs during childhood and, if untreated, persists lifelong (Malaty et al., 2002). The route of transmission is not fully known but it involves fecal-oral and oral-oral contacts primarily from mother to child (Mamishi et al., 2016; Konno et al., 2008; Okuda et al., 2019; Brown, 2000). Low education, parents' low education, poor dental hygiene, crowded living places in childhood and several other indicators of low socioeconomic status are the main risk factors for Hp infection (Nouria et al., 2009).

In addition to gastric cancer, chronic infection with Hp is causally

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Table 1

Non-genetic risk factors of gastric cancer, by subsite (adapted from Boffetta et al., 2014).

Risk factor	Cardia cancer	Non-cardia cancer
Old age	++	++
Male sex	++	++
Tobacco smoking	+	+
Family history of gastric cancer	++	++
Ionizing radiation	+	+
Helicobacter pylori infection		++
Low SES		++
Dietary salt intake		++
Intake of smoked food		+
Alcohol drinking	?	?
Overweight/obesity	++	
GERD	++	

++ Strong risk factor (relative risk <2).

+ Weak risk factor (1 < relative risk <2).

? Suspected risk factor.

associated with other gastrointestinal diseases, including gastritis, peptic ulcer, and gastric mucosa associated lymphoid tissue lymphoma (MALT) (Valenzuela et al., 2015). Moreover, Hp infection is also involved in extra-gastric diseases, including in particular idiopathic thrombocytopenic purpura, vitamin B12 deficiency and iron-deficient anemia (Gravina et al., 2018).

Despite most of the infections have an asymptomatic course, all chronically infected individuals develop chronic gastritis, which can become active in conjunction with concomitant factors, such as tobacco smoking, low-quality diet, and psychogenic stress (Gravina et al., 2018).

Because of its strong association with gastric cancer, Hp represents the most important infectious cause of cancer, with an estimated burden of 810.000 new cases per year (8.7 cases per 100,000 person-years) worldwide (de Martel et al., 2020). This represents approximately 89% of non-cardia gastric cancer, corresponding to 78% of all gastric cancer cases (IHPWG, 2014). Hp acts through a variety of virulence factors (Nejati et al., 2018) where Cag-A protein connotes the strain most strongly related to malignant transformation (Nejati et al., 2018; Hatakeyama, 2004; Park et al., 2018). Specifically, infection with CagA-positive compared to CagA-negative strains are associated to an almost 2-fold increased risk of non-cardia gastric cancer (Huang et al., 2003). Differences in the distribution of Hp strains contribute to the geographic heterogeneity of the association between Hp infection and gastric cancer risk (Brown, 2000).

The global prevalence of Hp infection is estimated to be higher than 50%, i.e., 4.4 billion individuals (Hooi et al., 2017), with inter- and intra-regional differences and a variability between different populations that has not still been systematically described. Public sanitation and progressive introduction of eradication strategies have contributed to limit Hp spreading, so that the infection has decreased over time in several countries (Leja et al., 2019). For example, the prevalence in Korea was 66.9% in 1998, 59.6% in 2005, 54.4% in 2011, and 43.9% in 2016–2017 (Leja et al., 2019). The evidence on the effectiveness of prevention of gastric cancer through Hp eradication is reviewed below.

2. Etiologic role of Helicobacter pylori infection in gastric carcinogenesis

Gastric carcinogenesis, described by Correa as a cascade (Fig. 1), is a long-latency process that affects susceptible individuals and passes through different pre-neoplastic lesions (Correa, 1988). It is sustained by inflammatory and immunological mechanisms which lead to progressive mucosal damage and neoplastic transformation (Valenzuela et al., 2015; Correa and Houghton, 2007; Liu et al., 2016).

Marshall and Warren first suggested a possible role for Hp in the etiology of gastric cancer (Marshall and Warren, 1984). Their hypothesis prompted laboratory, animal, and epidemiologic studies, which consistently demonstrated a causal association, leading to the classification of Hp as established human carcinogen in 1994 (International Agency for Research on Cancer, 1994).

Intervention studies have provided evidence that Hp eradication may reduce the risk of gastric cancer. A meta-analysis showed 35% reduction in gastric cancer risk in those who were treated for Hp (Fuccio et al., 2009). In addition, a randomized study of 544 patients with early gastric cancer showed a 65% reduction in the incidence of metachronous lesions in those who were treated for Hp (Fukase et al., 2008).

According to a large pooled analysis, the relative risk (RR) of non-cardia gastric cancer associated with Hp resulted to be 5.9, while no association was detected with cardia cancer (Helicobacter and Cancer Collaborative Group, 2001). The risk was lower (RR = 2.4) among those subjects who developed cancer within 10 years from Hp detection. This is due to the fact that the progressive damage caused by the microorganism compromises its own colonization of gastric mucosa. Thus, there might be an underestimate of cases attributed to Hp infection, as the bacterium might no longer be detectable when cancer occurs. When considering histological types (intestinal and diffuse), the relation between Hp infection and gastric cancer is comparable (Holton et al., 2011).

3. Screening and treatment of H. pylori infection

As for other cancer prevention interventions, there is a paradox due to the fact that those countries with a higher prevalence of infection are the ones with less possibility to set up a screening program because of the lack of resources, while preventive actions can be implemented in more developed countries, where the prevalence of Hp and the incidence of gastric cancer are relatively low. However, even in low-prevalence countries, there is a large proportion of the population at risk of developing gastric cancer, e.g., from 18.9 % in Switzerland to 26.2% in Sweden (Hooi et al., 2017).

Current evidence demonstrates that eradication therapy is the most powerful tool to prevent gastric cancer development, with at least a one third reduction of risk (Leja et al., 2019). A large number of studies corroborate the beneficial impact of eradication in term of gastric cancer prevention, which were included in systematic reviews and meta-analyses, including one by Fuccio and colleagues in which the OR 0.65 (95% CI, 0.43 to 0.98) in favor of treatment (Fuccio et al., 2009).

The value of primary prevention through Hp treatment is clearly stated in the Kyoto consensus guidelines, which state that “Hp infected

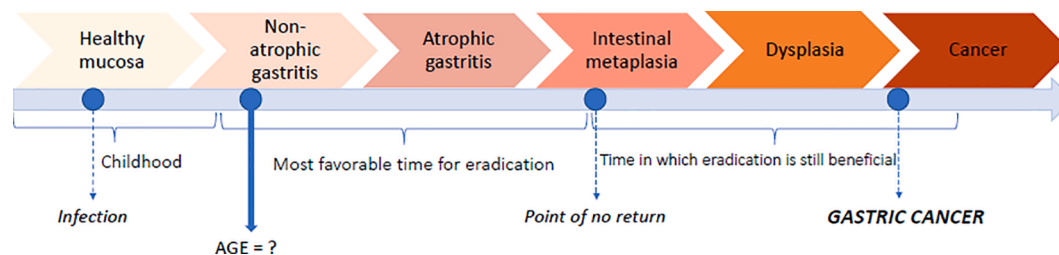


Fig. 1. Steps in gastric carcinogenesis and opportunities for prevention [18].

individuals should be offered eradication therapy, unless there are competing considerations” (Sugano et al., 2015). The justification of this statement stems from the fact that through eradication the pathogenesis of Hp-related diseases would be stopped (individual benefit), and the reservoir of infection would drastically decrease, with consequent economic and public health advantages.

Several noninvasive methods are available to detect Hp. Urea breath test (UBT) exploits the peculiar urease activity of Hp to assess the state of infection. It represents an ideal diagnostic test, because of its simple and quick execution and its great validity: studies report more than 95% of sensitivity and specificity before eradication and even higher values in assessing the success of the treatment (100% sensitivity, 98.6% specificity) (Gatta et al., 2006). Stool antigen test (SAT) seems to be better suited for screening protocols as it is cheaper than UBT, and it doesn't require the intervention of healthcare professionals. A prospective study conducted in Taiwan has proven the feasibility of the one-step Hp SAT in primary care setting and in the mass screening, with a sensitivity of 88%, a specificity of 100%, a positive predictive value of 100%, a negative predictive value of 89%, and an accuracy of 94% (Lee et al., 2014).

In most patients, Hp can be eradicated with the use of 7–14 days therapy combining a proton pump inhibitor and antibiotics (Malfertheiner et al., 2017). The eradication rate depends mainly on the sensitivity of the bacterial strain to antimicrobial drugs. The therapy for Hp has the important characteristic to be a short and, in most of cases, one-time-in-life treatment. In fact, reinfection is relatively infrequent and inversely correlated with country development, with a recurrence rate estimated to be 2.82 +/- 1.16% per patient-year globally (Yan et al., 2013).

Table 2 shows different first-line antibiotic regimens for Hp, according to different guidelines (Fallone et al., 2019). According to the most recent American College of Gastroenterology (ACG) guidelines, evidence-based first line therapies are clarithromycin triple therapy (PPI, clarithromycin and amoxicillin or metronidazole for 14 days), bismuth quadruple therapy (PPI, bismuth, tetracycline and nitroimidazole for 10–14 days) and concomitant therapy (PPI, clarithromycin, amoxicillin and nitroimidazole for 10–14 days) (Chey et al., 2017). If the first line fails, the second line therapy must avoid antibiotics that were previously administered.

Treatment outcomes have been recently studied by Nyssen and colleagues, who analyzed 21,533 subjects from the European Registry on Helicobacter pylori management (Hp-EuReg) who followed different

first-line eradication schemes between 2013 and 2018 (Nyssen et al., 2021). The results suggest that effectiveness varies by region and over time. Compliance clearly improves the effectiveness of any therapeutic protocol, while clarithromycin resistance reduces it to below 50%. From this review, quadruple therapies appear to be the only regimens able to guarantee and optimal (90% or more) eradication rate.

Primary resistance represents the main limitation to eradication, especially when considering therapies including macrolides (e.g., clarithromycin). This was recognized by the World Health Organization, which in 2017 put Hp clarithromycin-resistant among the high priority pathogens for which new antibiotics are urgently needed (World Health Organization, 2017). Moreover, a suboptimal compliance of the patient affects eradication range, so that the complexity of antibiotic administration (e.g., frequency and number of pills) should be considered when choosing the treatment.

Antibiotic susceptibility varies among populations, following the different patterns of antibiotic prescription between and within countries, as well as among different subpopulations. For example, resistance is more often observed in women who have been prescribed antibiotic for gynecological infections (Savoldi et al., 2018). This explains why even in areas where a specific antibiotic resistance is low there are niches of people with high prevalence of resistant Hp strains. Several studies have shown how clarithromycin resistance has spread over the years, showing that where Hp prevalence is low, antibiotic resistance does not increase considerably, while countries with high prevalence of infection are dramatically affected by this problem.

A variety of studies demonstrated that a test-and-treat strategy would be favorable in high-risk countries from Asia (Yeh et al., 2009; Han et al., 2020). However, relatively few data are available from lower risk countries. In a Swedish population-based study (Doorakkers et al., 2018) Doorakkers et al. observed a decreased risk of gastric adenocarcinoma, both considering the cardia and non-cardia types, during the follow up of 95,176 individuals who received eradication therapy: the standardized incidence ratio of non-cardia gastric cancer decreased proportionally with the time after treatment, from 10.7 (95% CI 7.77–14.4) at 1–3 years, to 0.43 (95% CI 0.16–0.93) at 5–7.5 years.

The cost-effectiveness of Hp screening has been further investigated in several model-based studies (Yeh et al., 2009; Han et al., 2020; Doorakkers et al., 2018; Kowada, 2018; Fendrick et al., 1999; Xie et al., 2008; Roderick et al., 2003; Teng et al., 2017; Leivo et al., 2004). These studies have been reviewed and meta analyzed by Lansdorp-Vogelaar and Sharp (2013) and Areia et al. (2013). Assumptions varied about key aspects, including infection prevalence, age range of screened population, sensitivity and specificity of Hp test, and adherence and effectiveness of treatment, this heterogeneity making difficult to outline a comprehensive frame. In particular, the assumed prevalence of infection varied from 13% in a study from Finland to over 40% in studies from Singapore and Japan (Kowada, 2018; Xie et al., 2008; Leivo et al., 2004). In all these analyses the intervention was estimated to be cost-effective, with larger benefit in populations with higher prevalence of infection.

Beside model-based studies, only few clinical trials have provided empirical evidence of the cost-effectiveness of eradication in countries where the prevalence of infection is low (Table 3) (Ford et al., 2005; Harvey et al., 2010; Høgh et al., 2019). Two trials from UK results in a positive effect of the intervention despite relatively low prevalence of infection, while a study from Denmark did not suggest an improvement in quality-adjusted life-years in the treated group; in the latter study, however, only 54% of the enrolled subjects were included in the follow-up.

Overall, both model-based and data-based studies showed that under most circumstances eradication of Hp is cost-effective, even in populations with low infection prevalence.

Specific subgroups of the population could be targeted for screening protocols, because of their higher risk of developing gastric cancer following Hp infection. Family history of gastric cancer appears to be an important risk factor independent of the bacterium. As a consequence,

Table 2

First-Line Treatment Recommendations by the Toronto Consensus, Maastricht V/Florence Consensus and the American College of Gastroenterology (ACG) Guidelines (modified from Fallone et al., 2019).

Therapy	Toronto	Maastricht V/ Florence	ACG
Bismuth quadruple therapy	R	R (only choice if high dual resistance*)	R
Concomitant therapy	R	R if high C-Res or if bismuth unavailable	R
PPI triple therapy	R in areas of <15% C-Res or proven eradication success >85%	R only in areas of low C-Res	R in areas of C-Res <15% and no previous macrolide exposure
Sequential and hybrid therapies	RAU	NR	S‡
Levofloxacin regimens	NR	–	S‡

R, recommended; NR, not recommended; RAU, recommended against use; S, suggested.

C-Res, clarithromycin resistance.

* Dual refers to resistance to both clarithromycin and metronidazole.

‡ Suggested means that the ACG finds it permissible for practice but not ideal.

Table 3
Characteristics of trial of cost-effectiveness of Hp eradication in asymptomatic individuals.

Reference	Country	Age	Method	Prevalence	FU duration	FU rate	Outcome	Result
Ford et al. (2005)	UK	40–49	UBT	27.6%	2 yr	90%	Cost	Positive
Harvey et al. (2010)	UK	20–59	UBT	15.5%	7 yr	97%	Treatment	Positive
Høgh et al. (2019)	Denmark	40–65	Ser + UBT	17.5%	13 yr	54%	QALY	Negative

UBT, urea breath test; Ser, serology; FU, follow-up; QALY, quality-adjusted life-years.

control of Hp infection can, at least in part, reduce the incidence of gastric cancer among individuals with family history: this population should therefore be screened and treated if Hp positive (El-Omar et al., 2000).

Based on these considerations, it is possible to devise a screen-and-treat protocol with multiple pathways (Fig. 2). In particular, as the development of gastric cancer implies a long latency, a screening program should take into consideration individual characteristics (Liu et al., 2016); in addition, all Hp positive subjects should be followed up after treatment to assess general health status, including symptoms occurrence, and adverse events attributable to antibiotics, and undergo second Hp testing to assess the successful eradication. Subjects ≥ 60 years of age and with symptoms, as well as those with a high-risk profile (e.g., family history of gastric cancer) should be recommended to undergo additional diagnostic procedures (Malferteiner et al., 2017; Moayyedi et al., 2017), including gastroscopy, in order to exclude the presence of lesions needing for further monitoring, while younger individuals would benefit of changes in their lifestyle and, if cured, would no longer represent a reservoir of infection for children.

Planning a standardized screening program, which would include a questionnaire on health status and possible risk factors of the individuals, would allow to collect complete and reliable data on the distribution of Hp infection and the identification of the population

subgroups to which further efforts should be addressed. A screening protocol would also entail general health implications, since making people aware of the presence of a risk factor, especially when asymptomatic, would enable them to make better choices in the daily life, possibly encouraging healthier behaviors that can positively impact their overall wellness. A population-based screening program, however, is not devoid of potential limitations. They are listed on Table 4, together with potential benefits. In particular, treatment failure and consequent facilitation of antimicrobial resistance in general population are of main concern in implementing test-and-treat protocols. Moreover, therapy can be burdened by side effects as diarrhea, abdominal pain, nausea, taste alteration, vomiting, and constipation (Shi et al., 2019). In particular, the occurrence of these symptoms reported in a meta-analysis was 39.0% in the controls compared to 18.9% when probiotics are added to the eradication scheme (Shi et al., 2019). An occupational-based screening for Hp would face several challenges and limitations. In order to avoid misconceptions on the importance, benefits and possible risks, an effective communication strategy would be required (Lier et al., 2019). The implementation of large-scale screening at workplaces would also require adequate testing setting, laboratory facilities and trained staff. These requirements would be particularly challenging in low- and medium-size enterprises. In addition, absenteeism might occur for workers who test positive for Hp, because of the

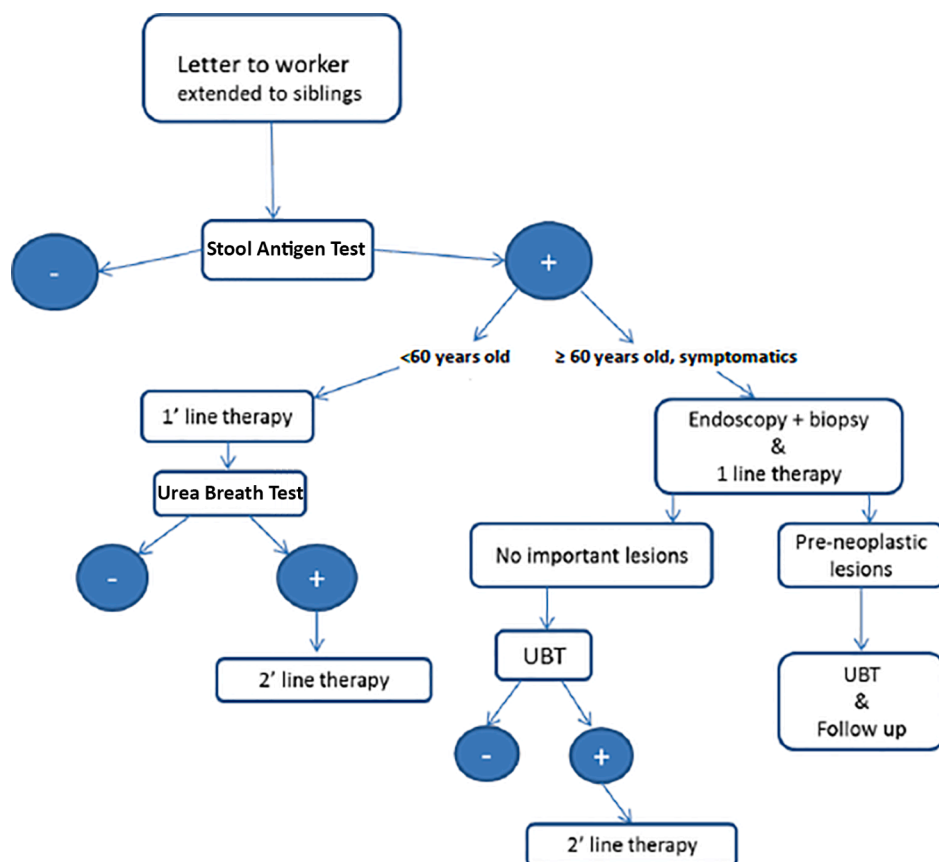


Fig. 2. Pathways in a workplace-based screen-and treat approach for Hp eradication.

Table 4

Potential benefits and limitations of a *population-based*[^] Hp screening program and additional specific benefits and limitations of a *workplace based*[§] Hp screening program.

Benefit [^]	Limitations [^]	Benefits [§]	Limitations [§]
Improved quality of life	Lack of compliance to therapy	Promotion of general wellbeing at the workplace	Need for communication strategy
Improved health status	Possibility of treatment failure due to strain	Healthier workforce	Need for testing setting and staff
Increased consciousness	resistance and adverse effects	Improved work performance	Possible absenteeism for additional procedures among Hp positive workers
Opportunity for disease treatment and prevention, reducing Hp-related burden of disease	Low participation in screening program [†]	Strengthened loyalty of the employee	Possible impact of side effects of therapy on working performance
Epidemiology description of Hp burden	Need for long follow-up for gastric atrophy and cancer	Increased workers satisfaction and happiness	
Identification of higher risk subgroups for infection	Endoscopy is needed for documenting mucosal damage	Reduction of sick leave due to gastric-related disease	
Feasibility of Hp testing*	Contraindication to therapy	Possibility to extend the screening and reach employees' family	
Possibility of reducing Hp reservoir	Antimicrobial resistance spreading pressure	Reduction of workplace reservoir of Hp	
Reduction of antibiotic use for Hp eradication in future generations		Optimal age group for primary prevention of gastric cancer	
Public health saving for gastric disease complications and gastric cancer		Help general practitioner management of the individual	
		Possible integration in more general health promotion programs already implemented	

* Characteristics of Hp testing: non-invasive, safe, fast, economic, highly sensible and specific.

[†] Possible reasons for low participation: fear of positive result, fear of therapy, fear of endoscopy, lack of interest, lack of time, inhibition about stool manipulation.

need for additional diagnostic procedures and treatment. Finally, the treatment itself might have a short-term impact on work performance because of its side effects, thus reducing the perception of long-term benefits of the intervention (Tsai et al., 2019; Reif et al., 2020).

4. Screening working populations for *Helicobacter pylori*

Occupation is a risk factor for Hp infection. A systematic review of 98 studies identified several high-risk occupational categories, including health professionals, especially among those working in gastrointestinal units, agricultural, forestry and fishery workers, as well as sewage workers, miners, and workers at institutions for the intellectually disabled (Kheyre et al., 2018).

The workplace directly influences the physical, mental, economic and social well-being of workers and in turn that of their families, communities and society (Schulte and Vainio, 2010; Eng et al., 2016; Goetzl and Pronk, 2010; Parkinson, 2018). In addition, the health of

workers is affected by extra-occupational factors, including infectious agents (Rebmann et al., 2009). Occupational medical surveillance programs offer an ideal setting and infrastructure to support the promotion of health of the workers. The recent COVID-19 epidemic offers an example of the potential of workplace-based intervention for disease prevention (Shaw et al., 2020; Baker et al., 2020; Rafeemanesh et al., 2020; Public Health Ontario, 2020). The use of occupational setting has also been considered for primary prevention of cancer (Lang et al., 2020; Nahmias et al., 2016; Marshall, 2013; Mojica et al., 2016). For example, high rates of screening for colorectal cancer have been achieved among employees (Mojica et al., 2016; Ou et al., 2019; Walsh et al., 2014).

Occupational health visits, that are mandated in many countries, offer an opportunity to screen healthy individuals for Hp infection, and to apply treatment strategies based on recommended practice (Fallone et al., 2019). Different health professionals would be involved in different steps of the process (Supplementary Fig. 2): occupational physician could invite workers to undergo Hp testing, explaining the meaning of a screening program for gastric disease and cancer and referring positive subjects to their general practitioner; this latter could prescribe eradication therapy to positive patients in the absence of contraindications, check the eradication outcome by a second Hp test and refer high-risk cases (e.g., old age, family history of gastric cancer) to the specialist in gastroenterology; finally, the gastroenterologist could take in charge the patient considering endoscopy, antimicrobial susceptibility testing, targeted therapy and follow-up.

Only a small number of studies investigated the effectiveness of this approach. Zober et al. determined the prevalence of Hp infection by serology in 6,143 workers in a chemical factory in Germany, and assessed its association with upper GI tract symptoms, personal history of ulcer, and family history of gastric cancer (Zober et al., 1998). The prevalence of infection, measured with immunoglobulin G serology, was 38.2%. Positive serology was weakly but consistently associated with cigarette smoking and shift work. Further diagnostic evaluation and eradication therapy was recommended in 795 workers (12.9%), based on a combination of positive serology and either upper GI tract complaints or family gastric cancer history. The therapy was completed for 541 workers (68.1%). These authors used aggregate medical claims data to evaluate the illness experience of 5,160 of the workers included in the surveillance program during the 2 years after versus the 2 years before the intervention (Ott et al., 2004). Across all participants, a 2.1-fold reduction (95% confidence interval [CI] 1.4–3.1) in ulcer-related illness episodes and a 1.1-fold reduction (95% CI 0.9–1.4) in episodes due to other stomach and duodenal diseases were observed. Improvement in claims experience was most notable among 250 employees with ulcer findings at the screening examination.

Madisch et al. studied the outcome of Hp eradication in 267 factory workers from Germany who reported uninvestigated chronic dyspepsia (Madisch et al., 2002). They assessed Hp infection status at baseline using the 13C-UBT, and positive workers (N = 111, 41.6%) were offered eradication therapy. Dyspeptic symptoms, quality of life and health care utilization were assessed by questionnaires at baseline, as well as at 2 and 12 month follow-up. The infection was cured in 90.4% of treated subjects. Upper abdominal pain and dyspeptic symptoms at 12 months were reduced and quality of life increased in Hp responders compared to baseline and to untreated subjects. In addition, disease-related absence from work, visits to family physicians, and antacid consumption were decreased in Hp responders compared with reference.

The limited evidence available from the literature offers support to the conclusions that (i) workplace-based surveillance for Hp infection is feasible and effective in identifying individuals for targeted interventions, and (ii) such interventions are effective in reducing the burden of Hp-associated disease. While no studies have included gastric cancer as outcome, as such studies would require a large population and a long follow-up and could not include for ethical reasons an untreated high-risk group, the available results imply that workplace-based screening and intervention might lead to the prevention of gastric

cancer.

5. Gastric cancer prevention at the workplace

Among the potential benefits gained through workplace-based screening and intervention are reduced sickness absence, reduced medical costs, improved productivity, reduced disease burden, as well as promotion of happiness and loyalty of workers (Reif et al., 2020). Because of disparities in access to surveillance across population groups, offering a screening on the workplace would represent an important contribution to health promotion, whose benefits extend beyond the working population (Kim et al., 2016). In this regard, workers constitute an ideal age group to target Hp screening, because the intervention might impact the transmission within families. In fact, household members of subjects colonized by Hp represent a group at high-risk subgroup for Hp-related diseases and should receive priority for testing (El-Serag et al., 2018). Indeed, family has been presented as a target for test-and-treat strategy in a recent work by Ding, so reaching families through screening among employees seems to meet this demand (Ding, 2020).

A screening program should be addressed to and be offered as a way to promote general wellbeing of the individual. In order to reach as many people as possible, public events have been used for cancer screening promotion (Escoffery et al., 2014). With regard to gastric cancer in particular, a test-and-treat strategy has been implemented in school setting in Japan (Kaji et al., 2020). Similarly, the workplace has already been recognized as an important environment for health promotion (Wanjau and Zapata-Diomed, 2019). In fact, workers represent an important segment of the general population. For this reason, a screen-and-treat strategy among workers would represent an approach that could be reproduced in other settings. This would offer the possibility to interrupt the circulation of the infection, providing a health benefit to the household and, in the long term, new generations. Even if only a fraction of those who test positive perform eradication therapy, the impact on the burden of Hp-related disease would be significant. As mentioned above, Table 4 illustrates potential advantages and limitations of a workplace-based Hp screening program. In particular, reduction of antibiotic use for Hp eradication in future generations is a potential benefit of this type of intervention, which may also lead to public health saving for gastric disease complications and gastric cancer.

In order to optimize the effectiveness of the intervention, detailed data are needed on the prevalence of infection in different occupational groups, taking into account the prevalence in the general population, and the possible interactions between occupational risk factors and Hp infection. Limited data are available on these issues, therefore additional studies on workplace determinants of Hp infection and on risk of gastric cancer would enable the comparison of risk between different groups of workers and the design of screening interventions.

In conclusion, an occupational screening for Hp would have a major public health impact. Its feasibility and cost-effectiveness should be assessed depending on the prevalence of infection, the distribution of Hp strains and other circumstances. Such a perspective would be highly innovative, since few trials have been conducted in occupational settings. Particular effort would be required to overcome common barriers towards screening including the motivation of occupational physicians and the population at large in the possibility to prevent gastric cancer by controlling its main etiological factor.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.pmedr.2021.101527>.

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