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Detection Rate of *Helicobacter Pylori* Infection and Atrophic Gastritis Using Serological Markers "GastroPanel®" Among Employees of the National Medical Research Radiological Centre of the Ministry of Health of the Russian Federation

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Aim: to evaluate, using the "GastroPanel®", the frequency of detection of *H. pylori* infection and associated gastric diseases among doctors and medical staff of the National Medical Research Radiological Centre of the Ministry of Health of the Russian Federation, Moscow.

Materials and methods. Employees of three branches of the National Medical Research Radiological Centre (n = 434, mean age — 48.5 ± 0.6 years) were examined using laboratory tests "GastroPanel®" (Biohit Oyj, Finland). The test results make it possible to identify infection of the stomach with *H. pylori,* hypo- and hyperacid conditions, as well as atrophic gastritis of the antrum and body of the stomach, as its precancerous conditions. Esophagogastroduodenoscopy (EGDS) for suspected atrophic gastritis was performed with an Olympus GIF-HQ190 video endoscope (Japan) in a narrow-spectrum mode with close focus (NBI Dual Focus).

Results. The absence of pathological signs detected by "GastroPanel®" was established in 23.3 % of cases, hyperacid state — in 18.4 %, and hypoacid state — in 5.2 %. These disorders are classified as functional. Consequently, the conditional norm in total was identified in 46.9 % of observations. An increased level of antibodies to *H. pylori* was found in 43.3 % of those examined. Atrophic gastritis in the body of the stomach according to the results of the "GastroPanel®" was detected in 4.8 % of cases (median age — 59 years), in the antrum (or increased secretion of hydrochloric acid) — also in 4.8 % of cases (median age — 52 years). Within two months after laboratory diagnostics, EGDS was performed for 10 out of 15 patients examined at the P. Hertsen Moscow Oncology Research Institute in whom, based on the results of the "GastroPanel®", the presence of atrophic gastritis in the antrum (or increased secretion of hydrochloric acid) was suspected. In 6 out of 10 cases, atrophic gastritis of the antrum was confirmed (in two of them, the atrophy extended to the body of the stomach and was assessed as severe). Of the 11 people with the "GastroPanel®" conclusion "Atrophic gastritis of the body of the stomach," an endoscopic examination was carried out in 7 persons, and in all these cases the diagnosis was confirmed, and in two people the conclusion was made of severe atrophic pangastritis.

Conclusion. "GastroPanel®" confirmed its high significance in identifying *H. pylori* infection and precancerous atrophic changes in the gastric mucosa. Regarding the occupational risks of infection among medical workers, we consider it advisable to conduct such screening without selecting an asymptomatic population.

Keywords: "GastroPanel®", medical workers, *Helicobacter pylori*, atrophic gastritis, esophagogastroduodenoscopy
Conflict of interests: the publication was supported by OOO "Melon", the exclusive distributor of Biohit Oyj (Finland) in the Russian Federation.

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Частота обнаружения инфекции *Helicobacter pylori* и атрофического гастрита с помощью серологических маркеров «ГастроПанель®» у сотрудников ФГБУ «НМИЦ радиологии» Минздрава России

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Цель исследования: с помощью серологических маркеров пепсиногена I, пепсиногена II, гастрина-17 и антител класса IgG к *H. pylori* («ГастроПанель®») оценить частоту инфекции *H. pylori* и ассоциированных с ней заболеваний желудка среди врачей и медперсонала ФГБУ «НМИЦ радиологии» МЗ РФ.

Материалы и методы. Сотрудники трех филиалов ФГБУ «НМИЦ радиологии» МЗ РФ (n = 434, средний возраст — 48,5 ± 0,6 года) были обследованы с использованием лабораторного набора «ГастроПанель®» («GastroPanel®», Biohit Oyj, Финляндия). При выявлении серологических маркеров атрофии желудка проведена эзофагогастродуоденоскопия (ЭГДС) видеоэндоскопом «Olympus GIF-HQ190» (Япония) в узкоспектральном режиме с близким фокусом (NBI Dual Focus).

Результаты. Отсутствие патологических изменений, выявляемых «ГастроПанелью®», установлено в 23,3 % случаев, гиперацидное состояние — в 18,4 %, а гипоацидное — в 5,2 %, что составило 46,9 % наблюдений. Повышенный уровень антител к *H. pylori* обнаружен у 43,3 % обследованных. Атрофический гастрит в теле желудка по результатам «ГастроПанели®» выявлен в 4,8 % наблюдений (медиана возраста — 59 лет), в антральном отделе — в 4,8 % наблюдений (медиана возраста — 52 года). В течение двух месяцев после лабораторной диагностики ЭГДС была выполнена 10 из 15 обследованным филиала МНИОИ им. П.А. Герцена, у которых по результатам «ГастроПанели®» заподозрено наличие атрофического гастрита в антральном отделе (или повышенной секреции соляной кислоты). В 6 из 10 случаев подтвержден атрофический гастрит антрального отдела (в двух из них атрофия распространялась и на тело желудка и расценена как тяжелая). Из 11 человек с заключением «ГастроПанели®» «Атрофический гастрит тела желудка» эндоскопическое исследование проведено у 7 лиц, и во всех этих случаях диагноз был подтвержден, причем у двух из них выставлено заключение «Тяжелый атрофический пангастрит».

Выводы и обсуждения. «ГастроПанель®» подтвердила высокую значимость в выявлении инфицированности *H. pylori* и предраковых атрофических изменений в слизистой оболочке желудка. Учитывая профессиональные риски инфицирования медицинских работников, считаем целесообразным проведение подобного скрининга независимо от наличия гастроэнтерологических симптомов.

Ключевые слова: «ГастроПанель®», медицинские работники, *Helicobacter pylori*, атрофический гастрит, эзофагогастродуоденоскопия

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Introduction

Stomach cancer is one of the most common in the structure of cancer incidence in Russia. Patients with gastric cancer in 1/3 of primary cases have stage IV disease, which causes their low survival rate [1, 2].

Treatment of precancerous changes in the gastric mucosa using endoscopic and minimally invasive surgical methods provides a favorable long-term prognosis and a good quality of life for patients [3].

These data are based on many years of research devoted to the search for effective methods of screening for early gastric cancer. Upper endoscopy is an effective method of early diagnosis, but it requires modern equipment and highly qualified specialists. Laboratory screening methods for solving these problems with high sensitivity and specificity have not yet been proposed.

At the same time, to date we have achieved significant knowledge of the etiology and pathogenesis of gastric cancer. Thus, chronic infection with *Helicobacter pylori* (*H. pylori*) as the main cause of chronic gastritis, leading to atrophy of the gastric mucosa, and peptic ulcers [4], as well as the description of the Correa cascade [5] caused

the classification of *H. pylori* as a carcinogen of the first order by the International Agency for Research on Cancer (IARC) in 1994. Some authors think that *H. pylori* is the cause of about 60 % of all cases of gastric cancer [5].

According to the results of the analysis of publications up to 2017 in Russia [6], *H. pylori* infection was detected in 65–92 % of the adult population (depending on the region), which is confirmed in later publications [7–10]. At the same time, according to the multicenter study of 2022, in recent years there has been a tendency to decrease the proportion of *H. pylori* infected [11].

Medical workers are at risk for *H. pylori* infection [12–14], this infection is detected in doctors 1.3–2.3 times more often than in people not associated with medical activities [15], and increases with age and work experience [15, 16]. The authors note a particularly high prevalence among gastroenterologists [17, 18], endoscopists [18], and nursing staff.

Since *H. pylori* eradication using the developed antibiotic therapy regimens has been proven to reduce the number of cases of stomach cancer [19], its detection and elimination is a step towards the prevention of this disease. Taking into account the stages of cancer development in *H. pylori*-infected stomach, a laboratory complex diagnostic method "GastroPanel®" (Biohit Oyj, Finland) was developed, including 4 tests that quantify blood levels: antibodies to *H. pylori,* levels of pepsinogen I (PGI), pepsinogen II (PGII) and gastrin-17b (G-17b), which together make it possible to indirectly detect infection of the stomach with *H. pylori*, hypo- and hyperacid conditions, as well as atrophic gastritis of the antrum and stomach body as a precancerous condition [20–22].

Currently, "GastroPanel®" is recommended by the U.S. Food and Drug Administration (FDA) for the detection for *H. pylori* infection and atrophic gastritis.

Among the Russian population, a population study using the "GastroPanel®" was initiated and performed in collaboration with Western colleagues in 2016 (St. Petersburg) [23]. The results of a database search indicate that no such studies were conducted in Russia during the coronavirus pandemic and subsequent years.

The aim of the study is to evaluate the frequency of detection of *H. pylori* infection and related stomach diseases among doctors and mid-level staff of the National Medical Research Radiological Centre of the Ministry of Health of the Russian Federation using "GastroPanel".

Materials and methods

Employees of all ages in all branches of the National Medical Research Radiological Center were asked to perform an examination using the laboratory test "GastroPanel®". The study included 434 participants — 421 employees and 13 members of their families, parents (the latter made up the oldest age group). The ratio of men and women among those examined was 1:5.9; the mean age was 48.5 ± 0.6 years (median — 49 years). The dominant group (40.9 %) was represented by the age group of 36–50 years.

Peripheral venous blood for research was collected on an empty stomach, in vacuum tubes with EDTA-K2. The blood plasma was separated by centrifugation at 3000 rpm, aliquoted and stored until the measurement procedure at –20 °C. The levels of PGI, PGII, G-17b and antibodies to *H. pylori* using a "GastroPanel®" (Biohit Oyj, Finland) were determined by enzyme immunoassays (EIAs). The optical density was measured using a Multiscan EX microplate photometer (Thermo Electron, Germany). The reference values of the markers, in accordance with the instructions for the kits, were as follows: PGI — 30–160 μg/L, PGII — 3–15 μg/L, PGI/PGII ratio — 3–20, G-17b — 1–7 pmol/L, antibodies to *H. pylori* — < 30 enzyme immunounits (EIU).

During the analysis of the obtained data, the automated interpretation of the results by the GastroSoft™ software was considered. Depending on the levels of four markers, the program gave one of six conclusions for each individual case (Table 1) [21], which are based on the Sydney Classification of gastritis [24]. In cases of conclusions of categories 5 and 6, gastroscopy was recommended to the examined persons, at the conclusion of category 4, it was recommended to conduct a respiratory test for the presence of *H. pylori*; at conclusions of categories 2 and 3, if necessary, to consult a gastroenterologist.

Upper endoscopy was performed using the Olympus EVIS Exera III system of the Olympus GIF-HQ190 endoscope (Japan) using the mode of narrow-spectral endoscopy with optical image magnification (NBI Dual Focus). The use of expert-class endoscopic equipment makes it possible not only to determine the type of atrophic gastritis directly in the process of endoscopic examination, but also to stage the degree and prevalence of atrophy. When examining the gastric mucosa in the NBI Dual Focus mode, the signs of its atrophy were the presence of whitish areas without a pitting pattern [25].

The etiopathogenetic classification of atrophic gastritis by R.G. Strickland and J.R. Mackay

Table 1. Options for interpreting the "GastroPanel®" results
Таблица 1. Варианты интерпретации результатов «ГастроПанели®»

CC КЗ	**PGI**	**PGII**	**PGI/ PGII**	**G-17b**	**Antibodies to *H. pylori* *Антитела к H. pylori***	**Interpretation *Интерпретация***	**Our recommendations *Наши рекомендации***
1	N	N	N	N	N	Healthy gastric mucosa (no atrophy, no *H. pylori*) *Здоровая слизистая (без атрофии, без инфекции H. pylori)*	–
2	N	N	N	L	N	Healthy gastric mucosa. High acid output *Здоровая слизистая. Повышенная секреция кислоты в теле желудка*	Consultation with a gastroenterologist (if necessary) *Консультация гастроэнтеролога (при необходимости)*
3	N or H *N или H*	N or H *N или H*	N	H	N	Healthy mucous membrane. Low acid output due to e.g. PPI medication *Здоровая слизистая. Пониженная секреция кислоты вследствие, например, приема ИПП*	Consultation with a gastroenterologist (if necessary) *Консультация гастроэнтеролога (при необходимости)*
4	N or H *N или H*	N or H *N или H*	N	N or H *N или H*	H	Active *H. pylori* infection *Активная инфекция H. pylori*	The urea breath test for the presence of *H. pylori*; if confirmed, specific therapy as prescribed by a gastroenterologist *Сдать дыхательный тест на наличие H. pylori; при подтверждении – специфическая терапия по назначению гастроэнтеролога*
5	L	L	L	H	N or H *N или H*	Atrophic gastritis in the corpus *Атрофический гастрит в теле желудка*	Esophagogastroduodenoscopy followed by consultation with a gastroenterologist *ЭГДС с последующей консультацией врача-гастроэнтеролога*
6	N	N	N	L	H	Atrophic gastritis in the antrum *Атрофический гастрит в антральном отделе желудка*	Esophagogastroduodenoscopy followed by consultation with a gastroenterologist *ЭГДС с последующей консультацией врача-гастроэнтеролога*

Note: CC – category of conclusion; assessment of marker levels: N – normal, L – low, H – high; PPIs – proton pump inhibitors.
Примечание: КЗ – категория заключения; оценка уровней маркеров: N – норма, L – понижен, H – повышен; ИПП – ингибиторы протонной помпы.

[26], the Kimura — Takemoto criteria [27] and the EGA (Endoscopic Gastric Atrophy) scale [28] were used in the conclusions of endoscopic studies.

According to the classification proposed in 1973 by R.G. Strickland and J.R. Mackay [26], all cases of atrophic gastritis are divided into three types, according to their etiology and pathogenesis:

- A — autoimmune, characterized by pronounced atrophy of the mucous membrane of the stomach body exclusively;
- B — *H. pylori*-associated (or post-*Helicobacter pylori*), in which atrophy is most often localized in the antrum of the stomach and, with its progression, spreads to the body of the stomach from the lower third to the upper one;
- C — chemical (reflux), characterized by the presence of inflammation and, in some cases, atrophy in the antrum of the stomach, developing as a result of the damaging effect of bile.

In some cases, polyetiological pangastritis of types A + B or A + B + C can be observed, when atrophy is detected simultaneously in the body and antrum of the stomach, and its causes are both the production of antibodies to parietal cells and the effects of *H. pylori* and bile [29].

According to the Kimura — Takemoto classification [27], criteria for the prevalence of gastric mucosal atrophy along the horizontal (C) and vertical (O) axes are used (Table 2):

- C1 — atrophy spreads from the antrum to the corner of the stomach;
- C2 — atrophy is detected along small curvature in the lower and middle third of the stomach body;
- C3 — atrophy is detected in the upper third of the stomach body;
- O1 — atrophy is limited by a small curvature;
- O2 — atrophy spreads to the anterior and posterior walls;
- O3 — atrophy is detected along large curvature.

The endoscopic scale for assessing the degree and prevalence of gastric mucosal atrophy according to K. Kimura and T. Takemoto has undergone changes twice since its appearance. The latest modification, developed in 2017 by J.H. Song et al., called Endoscopic Grading Atrophy (EGA), seems to be the most convenient for both practical application and statistical analysis [28]. According to it, only 3 degrees of prevalence of gastric mucosal atrophy should be distinguished (Table 2):

- EGA I — mild (C1, C2);
- EGA II — moderate (C3, O1);
- EGA III — severe (O2, O3).

Statistical data processing was carried out using the Statistica 12.6 software package (IBM SPSS Statistics 23, USA), as well as Microsoft Excel 2010 (Microsoft Corp., USA).

Results

The age distribution of the examined persons shown in Fig. 1 was close to that among all employees of the Center. The ratio of men and women in the screening group was 1:5.9, and among all employees of the Center — 1:3.1.

The primary analysis of the conclusions based on the results of the study of the levels of four markers of the "GastroPanel®", issued by the GastroSoft™ program, is presented in Table 3. The absence of pathological changes detected by the "GastroPanel®" was found only in 23.3 % of the examined persons; increased secretion of hydrochloric acid — in 18.4 % of young people, and decreased secretion of hydrochloric acid — in 5.2 % of cases in the older age group of the examined cohort. Increased levels of antibodies to *H. pylori* was detected in 43.3 % of the examined patients, and in a quarter of them it was extremely high (> 670 EIU), exceeding the values of the highest calibrator.

Table 2. Assessment of the prevalence and severity of atrophy of the gastric mucosa in accordance with the EGA scale and Kimura — Takemoto criteria [27]

Таблица 2. Оценка распространенности и тяжести атрофии слизистой оболочки желудка в соответствии со шкалой EGA и критериями Kimura — Takemoto [27]

<table>
<tr><th colspan="2" rowspan="2">Degree of atrophy
Степень атрофии</th><th colspan="3">EGA (J.H. Song et al., 2017)</th></tr>
<tr><th>EGA I</th><th>EGA II</th><th>EGA III</th></tr>
<tr><td rowspan="6">EGA
(K. Kimura,
T. Takemoto, 1996)</td><td>C1</td><td rowspan="2">Mild atrophy
Слабая атрофия</td><td rowspan="3">Moderate atrophy
Умеренная атрофия</td><td rowspan="6">Severe atrophy
Тяжелая атрофия</td></tr>
<tr><td>C2</td></tr>
<tr><td>C3</td><td></td></tr>
<tr><td>O1</td><td></td><td></td></tr>
<tr><td>O2</td><td></td><td></td></tr>
<tr><td>O3</td><td></td><td></td></tr>
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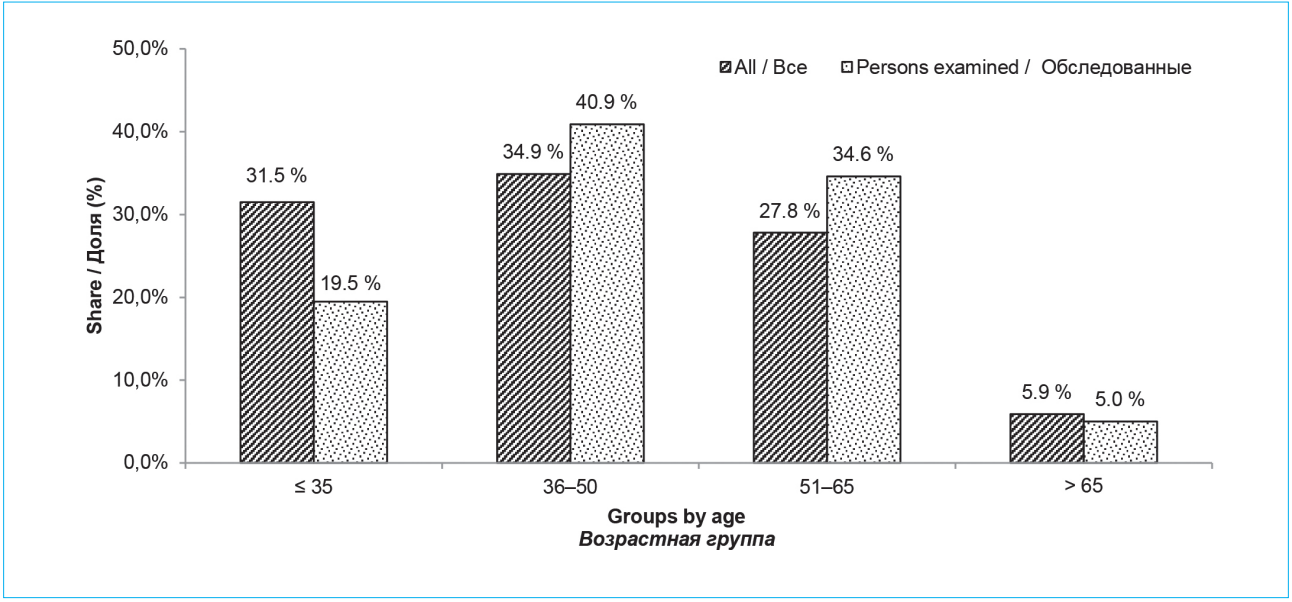

Figure 1. Distribution of examined persons and all employees of the Center by age

Рисунок 1. Распределение обследованных и всех сотрудников Центра по возрасту

Table 3. Results of the study of "GastroPanel®" markers and the age of the participants (data for the National Medical Research Radiological Centre)

Таблица 3. Результаты исследования маркеров «ГастроПанели®» и возраст участников (данные по ФГБУ «НМИЦ радиологии» МЗ РФ)

CC ***КЗ***	**Basic information on the conclusion** ***Основная информация по заключению***	***n* (%)**	**Age, years** ***Возраст, лет*** **Me (Q1; Q3)**
1	Absence of disturbances in the secretion of HCl, *H. pylori*, atrophic gastritis *Отсутствие нарушений секреции HCl, H. pylori, атрофического гастрита*	101 (23.3 %)	47 (37; 56)
2	Increased HCl secretion *Повышенная секреция HCl*	80 (18.4 %)	43 (32; 54)
3	Decreased HCl secretion *Пониженная секреция HCl*	23 (5.2 %)	55 (47; 63)
4	*H. pylori* infection *Инфекция H. pylori*	188 (43.3 %)	50 (42; 58)
5	Atrophic gastritis in the body of the stomach *Атрофический гастрит в теле желудка*	21 (4.8 %)	59 (52; 62)
6	Atrophic gastritis in the antrum of the stomach, or increased secretion of HCl *Атрофический гастрит в антральном отделе желудка либо повышенная секреция HCl*	21 (4.8 %)	52 (45; 57)
Total / *Всего*		434	49 (39; 58)

Note: CC — category of conclusion.

Примечание: КЗ — категория заключения.

The results of the determination of four markers of the "GastroPanel®" indirectly indicated the presence of atrophic gastritis in the stomach body in 21 of the 434 examined (4.8 %), and all of them belonged to the older age group (Table 3). Conclusions on the probability of the presence of atrophic gastritis in the antrum, or on increased secretion of hydrochloric acid only were obtained in 21 of the 434 surveyed (4.8 %). These two categories of individuals were recommended to have an upper endoscopy.

The results of the upper endoscopy were analyzed for employees of one of the branches — the P. Herzen Moscow Oncology Research Institute.

Within two months after laboratory diagnosis, upper endoscopy was performed in 7 out of 11 (64.6 %) employees of the P. Herzen Moscow Oncology Research Institute from the group "Atrophic gastritis in the body of the stomach" and in 10 out of 15 (66.7 %) employees from the group "Atrophic gastritis in the antrum, or increased secretion of hydrochloric acid".

Table 4 systematizes the endoscopic findings in 10 examined patients, to whom the GastroSoft™ program gave a conclusion about the presence of *H. pylori* infection (due to increased levels of antibodies to *H. pylori*) and the probability of atrophic gastritis in the antrum of the stomach (justification — low G-17b level in combination with high levels of antibodies to *H. pylori*) or only increased secretion hydrochloric acid (justification — low G-17b level).

In 6 out of 10 examined patients of this subgroup, endoscopy confirmed the presence of atrophic gastritis; in one observation, non-atrophic reflux gastritis was detected; in three examined patients, in accordance with the concept of "GastroPanel®", the totality of analyses should be interpreted as increased secretion of hydrochloric acid in the stomach. According to endoscopic signs, atrophic gastritis in 5 out of 6 cases was considered *H. pylori*-associated, which is consistent with the presence of high titers of antibodies to *H. pylori*; in one case, atrophic gastritis of combined etiology (*H. pylori*-associated + autoimmune) was established (Table 4). In 3 out of 5 cases with staging *H. pylori*-associated gastritis atrophy was observed mainly in the antrum of the stomach (C1—C2); in 2 cases, atrophic gastritis spread to the body of the stomach. In 3 out of 5 cases, atrophy was regarded as mild, in two cases — as severe (Table 4).

The applicability of the "GastroPanel®" to assess the presence and genesis of atrophy is illustrated by clinical observation. In Subject No. 3, a woman, 55 years old, as part of noninvasive screening of precancerous changes in the gastric mucosa, "GastroPanel®" tests were performed, which indirectly indicated the presence of *H. pylori* infection; low G-17b levels were also observed (Table 5).

These results indicated either increased secretion of hydrochloric acid in the stomach or atrophic gastritis of the antrum of the stomach. To differentiate these two variants, the GastroSoft™ analytical system recommends performing EGDS

Table 4. Endoscopic findings during EGD in individuals who received a conclusion from the GastroSoft™ program "*H. pylori* infection; the results indicate either atrophic gastritis of the antrum of the stomach, or increased secretion of hydrochloric acid"

Таблица 4. Эндоскопические находки при ЭГДС у лиц, получивших заключение программы GastroSoft™ «Инфекция *H. pylori*; результаты свидетельствуют либо об атрофическом гастрите антрального отдела желудка, либо о повышенной секреции соляной кислоты»

No. / №	Atrophy *Атрофия*	Type of gastritis (ABC) *Тип гастрита (ABC)*	K-T* atrophy *K-T* атрофия*	EGA atrophy *EGA атрофия*
1	Yes *Да*	B	C1	I
2	Yes *Да*	B	O3	III
3	Yes *Да*	B	C2	I
4	Yes *Да*	B	C1	I
5	Yes *Да*	B	O3	III
6	Yes *Да*	A + B	n/st** *н/ст***	n/st *н/ст*
7	No *Нет*	C	n/st *н/ст*	n/st *н/ст*
8	No *Нет*	–	–	–
9	No *Нет*	–	–	–
10	No *Нет*	–	–	–

Note: * — atrophy according to K. Kimura, T. Takemoto; ** — not staged.

Примечание: * — атрофия по K. Kimura, T. Takemoto; ** — не стадируется.

Table 5. Results of "GastroPanel®" tests for Subject No. 3
Таблица 5. Результаты тестов «ГастроПанели®» обследуемой № 3

Marker / *Маркер*	Level / *Уровень*	Norm / *Норма*
Pepsinogen I (PGI) *Пепсиноген I (PGI)*	67.0 μg/L *67,0 мкг/л*	30–160 μg/L *30–160 мкг/л*
Pepsinogen II (PGII) *Пепсиноген II (PGII)*	11.0 μg/L *11,0 мкг/л*	3–15 μg/L *3–15 мкг/л*
PGI/PGII	6.1	3–20
Gastrin-17b (G-17b) *Гастрин-17b (G-17b)*	< 1 pmol/L *< 1 пмоль/л*	1–7 pmol/L *1–7 пмоль/л*
Antibodies to *H. pylori* *Антитела к H. pylori*	> 670.0 EIU	< 30 EIU

or measuring the amount of G-17b after protein stimulation.

The employee underwent endoscopy in the P. Herzen Moscow Oncology Research Institute, which identified circular atrophy of the mucous membrane of the antrum of the stomach with minor atrophy along a small curvature in the lower third of the stomach body, which, according to the Kimura — Takemoto classification, corresponds to a closed type of C2 atrophy (Figs. 2, 3), and according to the EGA scale — to Category I. Typical endoscopic signs of *H. pylori*-associated gastritis were also identified, such as enlarged gastric fields, deepened furrows, pseudoborrows, expanded and elongated pits of the epithelium of the stomach body (Fig. 4), surrounded by a whitish corolla (Fig. 5), which indicates the activity of the process and correlates with the data of the "GastroPanel®". Contamination of the gastric mucosa of *H. pylori* was confirmed by cytological examination of biopsies.

The results of an endoscopic examination in the subjects with the conclusion of the GastroSoft™ program "Atrophic gastritis of the stomach body due to an autoimmune disease or a previous *H. pylori* infection" are systematized in Table 6. The justification for such a conclusion of the program were the levels of PGI and PGII, PGI/PGII ratio, and G-17b levels below the lower limit of the norm in combination with the absence of increased levels of antibodies to *H. pylori* (the exception is observation No. 6, in which a slightly increased level of antibodies to *H. pylori* was noted).

According to the results of endoscopy, all examined employees of this group had atrophy of the gastric mucosa (Table 6). At the same time, in 5 out of 7 examined persons atrophy was of a mixed nature (types "A + B", "A + C"

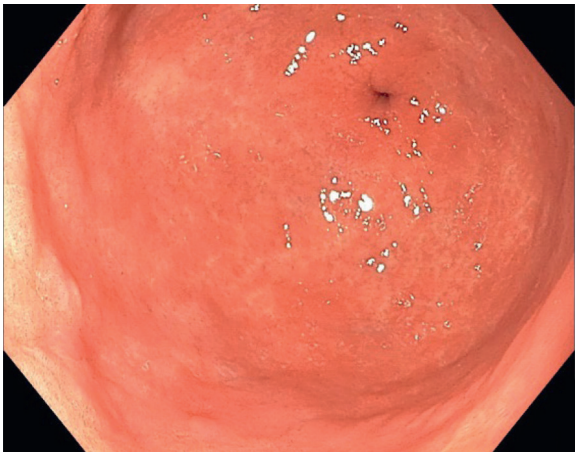

Figure 2. Atrophy of the mucous membrane of the antrum of the stomach (white light examination)

Рисунок 2. Атрофия слизистой оболочки антрального отдела желудка (осмотр в белом свете)

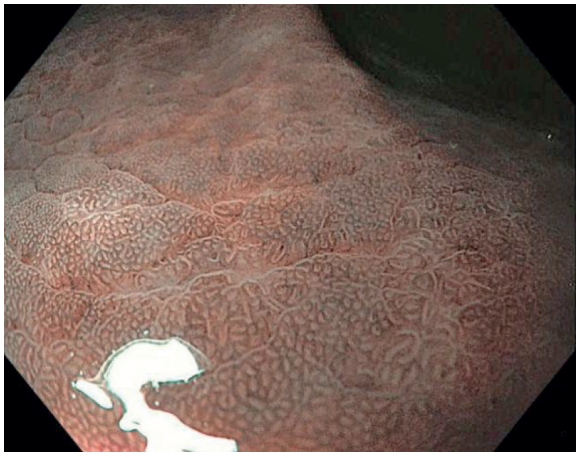

Figure 3. Atrophy of the mucous membrane of the antrum of the stomach (examination in NBI Dual Focus mode)

Рисунок 3. Атрофия слизистой оболочки антрального отдела желудка (осмотр в режиме NBI Dual Focus)

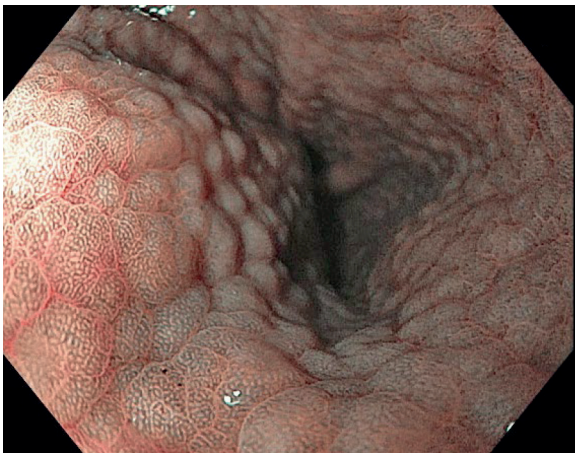

Figure 4. Dilated and elongated pits of the epithelium of the mucous membrane of the body of the stomach (examination in NBI Dual Focus mode)

Рисунок 4. Расширенные и удлиненные ямки эпителия слизистой оболочки тела желудка (осмотр в режиме NBI Dual Focus)

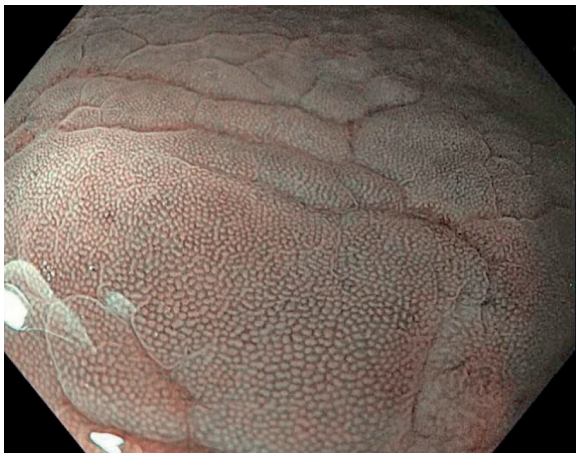

Figure 5. Whitish rims around the pits (examination in NBI Dual Focus mode)

Рисунок 5. Белесоватые венчики вокруг ямок (осмотр в режиме NBI Dual Focus)

Table 6. Endoscopic findings during EDG in the examined individuals in cases classified by the conclusion of the GastroSoft™ program into the category "Atrophic gastritis of the body of the stomach due to an autoimmune disease or previous *H. pylori* infection"

Таблица 6. Эндоскопические находки при ЭДГС у обследованных лиц в случаях, отнесенных заключением программы GastroSoft™ к категории «Атрофический гастрит тела желудка вследствие аутоиммунного заболевания или перенесенной инфекции *H. pylori*»

No. / №	Atrophy *Атрофия*	Type of gastritis (ABC) *Тип гастрита (ABC)*	K-T* atrophy *K-T* атрофия*	EGA atrophy *EGA атрофия*
1	Yes *Да*	A + C	n/st** *н/ст***	n/st *н/ст*
2	Yes *Да*	B	O3	III
3	Yes *Да*	B + C	O2	III
4	Yes *Да*	A + B + C	n/st *н/ст*	n/st *н/ст*
5	Yes *Да*	A + B	n/st *н/ст*	n/st *н/ст*
6	Yes *Да*	A + B	n/st *н/ст*	n/st *н/ст*
7	Yes *Да*	B + C	C2	I

Note: * — atrophy according to K. Kimura, T. Takemoto; ** — not staged.

Примечание: * — атрофия по K. Kimura, T. Takemoto; ** — не стадируется.

or "A + B + C" according to the classification of R.G. Strickland and J.R. Mackay), that is there were atrophic changes in the mucous membrane that were regarded as pangastritis with damage to the body and antrum of the stomach, and atrophy in the stomach body had autoimmune genesis. It should be noted that autoimmune gastritis (type A) is not recommended to be staged on the EGA scale, since the patterns of atrophy in such situations do not meet the Kimura — Takemoto criteria. In the two remaining patients, atrophy spread from the antrum of the stomach to the body of the stomach and was quite pronounced (O2 and O3, according to the Kimura — Takemoto classification, Grade III — on the EGA scale). In our opinion, endoscopic examination using expert-class equipment makes it possible to differentiate atrophy of the

Table 7. Results of "GastroPanel®" tests in the Subject No. 1
Таблица 7. Результаты тестов «ГастроПанели®» у обследуемой № 1

Marker / *Маркер*	Level / *Уровень*	Norm / *Норма*
Pepsinogen I (PGI) *Пепсиноген I (PGI)*	< 10 μg/L *< 10 мкг/л*	30–160 μg/L *30–160 мкг/л*
Pepsinogen II (PGII) *Пепсиноген II (PGII)*	10.6 μg/L *10,6 мкг/л*	3–15 μg/L *3–15 мкг/л*
PGI/PGII	0.9	3–20
Gastrin-17b (G-17b) *Гастрин-17b (G-17b)*	> 30.0 pmol/L *> 30,0 пмоль/л*	1–7 pmol/L *1–7 пмоль/л*
Antibodies to *H. pylori* *Антитела к H. pylori*	< 15 EIU	< 30 EIU

stomach body due to the autoimmune process and *H. pylori*. Thus, atrophy in type A gastritis will be most pronounced in the body of the stomach along large curvature, while in type B gastritis with widespread atrophy, these changes will prevail along small curvature.

The following clinical observation corresponds to the described data. Female subject No. 1, 50 years old, underwent "GastroPanel®" tests as part of noninvasive screening of precancerous changes in the gastric mucosa. According to the results obtained, the woman has a reduced PGI, a reduced PGI/PGII ratio and an increased G-17b level (Table 7).

The data indicate the presence of atrophy of the mucous membrane of the proximal parts of the stomach either as a result of autoimmune gastritis (which is more likely) or as a result of a past *H. pylori* infection. An increased level of G-17b indicates a decrease in the secretory activity of the stomach, which is more typical for atrophic gastritis of autoimmune origin.

The employee underwent an endoscopy, which revealed pronounced atrophy of the stomach body — thinning of the mucous membrane of the bottom and body of the stomach (Fig. 6), when examined in the NBI Dual Focus mode, whitish areas of mucosal atrophy devoid of pits were visualized (Fig. 7). The mucous membrane of the antrum corresponded to the norm, examined both in white light and in the narrow-spectrum mode. Also, typical signs of *H. pylori* contamination were not detected. Based on the data obtained during endoscopic examination, the picture of chronic atrophic gastritis of autoimmune origin was not in doubt.

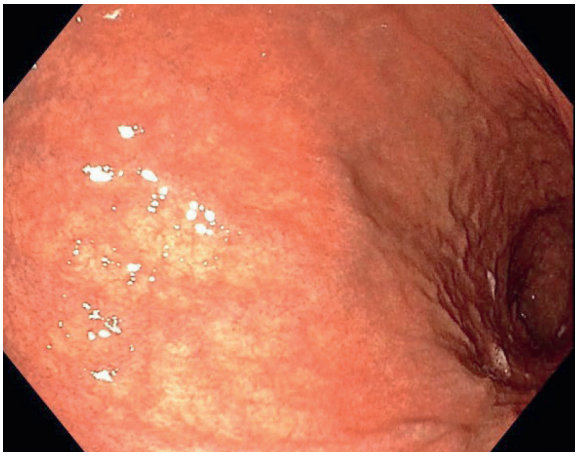

Figure 6. Atrophy of the mucous membrane of the proximal parts of the stomach (white light examination)

Рисунок 6. Атрофия слизистой оболочки проксимальных отделов желудка (осмотр в белом свете)

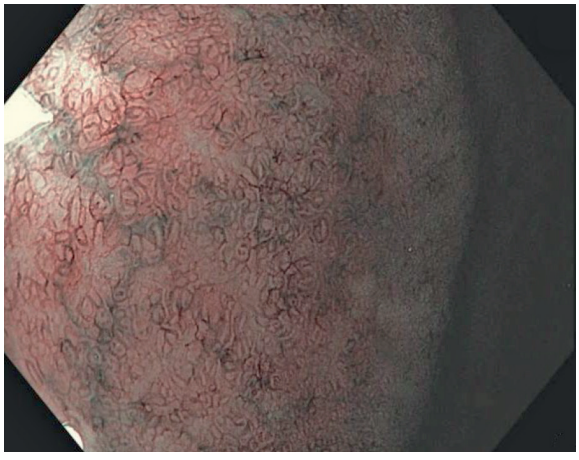

Figure 7. Atrophy of the mucous membrane of the proximal parts of the stomach (examination in NBI Dual Focus mode)

Рисунок 7. Атрофия слизистой оболочки проксимальных отделов желудка (осмотр в режиме NBI Dual Focus)

Discussion

This study presents the results of screening of employees of three branches of National Medical Research Radiological Centre, carried out using "GastroPanel®" tests and aimed at detecting cases of *H. pylori* infection, various variants of atrophic gastritis and functional disorders in the stomach (hypo- and hyperacid conditions). The research included 434 participants, including 13 family members.

The peculiarity of the study was the absence of age restrictions and the presence of any gastroenterological symptoms. Therefore, the screening was of an "opportunistic" nature, as part of a voluntary medical examination "at the workplace".

All participants of the program were over 25 years old, the median age was 49 years, the distribution of subjects by age corresponded to that of all employees of the Center. Consequently, employees of all age groups responded equally to the offer to participate in the screening. At the same time, it should be noted that the number of men among examined persons turned out to be almost 6 times less than that one of women (1:5.9) even though among all employees of the Center this ratio was 1:3.1. For the preparation of programs of this type it is important to consider that men are less eager to undergo examination, taking into account that stomach cancer occurs with equal frequency in men and women [1].

The absence of secretion disorders, *H. pylori* and atrophic gastritis in general was detected in 23.3 % of cases, hyperacid condition — in 18.4 % (in the youngest group, median — 43 years), and hypoacid condition — in 5.2 % of cases (in the older age group, median — 55 years). These disorders are functional, and, as a result, are a variant of the norm (within the framework of conditions detected by the "GastroPanel®"). Consequently, the conditional norm was generally detected in 46.9 % of the observations. This is twice the number of cases of the conditional norm (21.7 %) established during the examination of the asymptomatic population of St. Petersburg in 2016 [23]. The cited work presents data from a survey of 918 people (646 women and 272 men) aged 26–83 years (mean age — 51.8 years). According to formal criteria, our study and the study performed in St. Petersburg included a similar contingent of participants, with the difference that we did not impose such a restriction on participation as the absence of symptoms of diseases of the gastrointestinal tract. It cannot be excluded that the lower frequency of stomach disorders in medical staff that we have identified is associated with more careful observance of sanitary standards and proper nutrition of their diet than in general population.

Among the staff of the Center, an increased level of antibodies to *H. pylori* (indirectly indicating infection of the gastric mucosa) was found in 43.3 % of the surveyed, which is close to the indicators of such countries as Great Britain (35.3 %), Germany (35.3 %), the USA (35.6 %) [30]. According to the meta-analysis of publications for 1970–2016, the infection rate in Russia was higher than 80 % [30]. The high level of *H. pylori* infection (80–90 %) in different regions of Russia is confirmed by Russian publications [6–10, 23]. In the above-cited publication L.D. Roman et al. [23] on the results of a survey of the population of St. Petersburg, an increased level of antibodies to *H. pylori* was detected in 76.7 % of the surveyed.

It is recognized that the infection rate is related to hygiene standards. Probably, lower infection rates among the Center's staff are associated with a more responsible approach to hygiene in the medical community and in everyday life compared with the common Russian population. On the other hand, it cannot be excluded that the relatively low *H. pylori* infection rate in the staff of the Center is comparable to the general trend of decreasing *H. pylori* prevalence in Russia [11]. At the same time, in this aspect, the publication of N.V. Bakulina et al. [16] is of particular interest, which provides the results of an examination of 1,154 doctors from 14 regions of Russia using a ^{13}C urease ("respiratory") test for the presence of *H. pylori*. The authors found that the infection rate of doctors increases with age (> 30 years — 45.2 %; 51–60 years — 60–65 %) and correlates with work experience. Similar foreign publications [18] demonstrate that the incidence of infection depends on the medical specialty: it is maximal in endoscopists and high in surgeons, hematologists, gastroenterologists, and is the lowest in therapists.

The focus of this study is to identify atrophic gastritis as a precancerous disease. Approximately 10 % of *H. pylori* infected patients develop chronic atrophic gastritis and 1–5 % of them develop intestinal type of gastric cancer [20, 31]. According to the results of the "GastroPanel®", atrophic gastritis in the stomach body was detected in 4.8 % of observations (21/434) in the older age group (median age — 59 years), in the antrum (or increased secretion of hydrochloric acid) — also in 4.8 % (median age — 52 years). These figures are more than 10 times higher than those obtained using the "GastroPanel®" and published

in the meta-analysis by K. Syrjänen [32]: chronic atrophic gastritis of the stomach body was detected in 0.3 % of observations, of the antrum — in 0.2 %. However, in the cited study [32], screening was performed in an asymptomatic population. At the same time, L.D. Roman et al. [23] according to the conclusion of the "GastroPanel®" revealed atrophic gastritis of the stomach body in 7.5 % of the examined Russians, pangastritis — in 1 % and atrophic gastritis of the antrum — in 2.3 %. We believe that the higher percentage of atrophic gastritis that we identified (in comparison with the meta-analysis data presented in [32]) is due to at least two reasons: inclusion in the study regardless of the presence of gastroenterological symptoms and the awareness of some of the people who took part in screening about the presence of atrophic gastritis according to a previously performed upper endoscopy.

The results of the targeted follow-up examination — upper endoscopy using expert class endoscopic equipment — were analyzed for employees of one of the branches of the Center (P. Herzen Moscow Oncology Research Institute). Of the 15 people in which atrophic gastritis in the antrum was suspected (or increased secretion of hydrochloric acid), according to the results of the "GastroPanel®", an endoscopic examination was performed in 10 persons. Atrophic gastritis of the antrum was confirmed in 6 out of 10 cases (in two of them, atrophy spread to the body of the stomach and was regarded as severe). In 4 out of 6 cases, it was newly diagnosed. Of the 11 people with the conclusion of the "GastroPanel®" "Atrophic gastritis of the body of the stomach", an endoscopic examination was performed in 7 persons, and in all these cases the diagnosis was confirmed, in two of them severe atrophic pangastritis was diagnosed. All the examined patients from this group were diagnosed for the first time.

Conclusion

"GastroPanel®" has confirmed its high importance in detecting *H. pylori* infection and precancerous atrophic changes in the gastric mucosa. Considering the occupational risks of infection for medical workers, we consider it not only appropriate but also necessary to conduct such screening without selecting an asymptomatic population.

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