Law for the Aged, employer medical examination, and personal medical examination. Gastric cancer screening using photofluorography indicated reduction of mortality in meta-analysis including three Japanese case-control studies, but its evidence level is not strong, i.e., equivalent to IVa in MINDS (Medical Information Network Distribution Service) classification. (42) The sensitivity of photofluorography ranged from 60% to 80%, whereas the specificity and true positive rate were 90% and 0.7-2.0%, respectively. In overall results of Japanese cancer screening in 2007, the number of persons who received gastric cancer screening using photofluorography and the number of detected gastric cancers were about 6,390,000 and 5,600, respectively. However, endoscopic examination as close examination found gastric cancer at a different site in the half of screen-detected gastric cancers. True detection rate of early gastric cancer using photofluorography is known to be not so high. Current gastric cancer screening using photofluorography has various well-known problems, such as low consultation rate of close examination and immobilization of participant. Recently, the prevalence rate of *H. pylori* infection in less than 50-year-old Japanese has decreased to less than 40%. (43) Since more than half of participants in gastric cancer screening have low risk of gastric cancer, it is a serious problem that *H. pylori* negative persons have to receive photofluorography every year in terms of radiation exposure. Unnecessary annual invasive screening examinations for *H. pylori* negative population should be avoided. Therefore, it is necessary to reconsider mass screening program of gastric cancer using photofluorography.

ii) Endoscopic examination

Recently, endoscopic screening for gastric cancer has been used gradually according to the spread of transnasal esophagogastroduodenoscopy. (44) Transnasal endoscopy is suitable for gastric cancer screening because of good compliance by participants. (45)(46) Mass screening using endoscopic examination has some problems such as the need for an endoscopist, performance limitation of operation number, sterilization of scope, complication of endoscopy, and low acceptability of participant. Endoscopic examination has been the best for finding early gastric cancer, with a detection ratio of 0.87% in 2004, approximately about 3 to 5 times higher than those of photofluorography. (47) The efficacy of endoscopic screening in term of mortality reduction in Japan has been compared to that of X-ray examination (48): 4,261 residents underwent gastric X-ray examination for gastric cancer screening from 1991 to 1995, and all 7,178 residents underwent endoscopic examination for the same purpose from 1996 to 2003. Following the introduction of endoscopic screening, the age-adjusted gastric cancer mortality rates decreased from 1.04 (95% CI 0.50-1.58) to 0.71 (95% CI 0.33-1.10) for males and from 1.54 (95% CI 0.71-2.38) to 0.62 (95% CI 0.19-1.05) for females. Reduction of gastric cancer mortality was achieved by not only increase in the detection of early cancer using endoscopic screening but also improvement of the treatment including surgery.

iii) Serum pepsinogen test

Pepsinogen (PG) is precursor for pepsin produced in gastric mucosa, of which 99% is secreted into the gastric lumen and 1% into the blood stream. PG is classified into two biochemically and immunologically different isozymes, namely PG I and PGII. While PG I is produced in chief and mucous neck cell of fundic glands, PG II is secreted from the fundic, pyloric, and proximal duodenal glands. (49)(50) Serum PG level reflects the morphology and function of acid secretary glands and pathological condition of gastric mucosa such as inflammation. (51)-(53) Inflammation of gastric mucosa by *H. pylori* infection elevates serum PG I and PG II levels and decreases PG I/II ratios due to relative high elevation of PG II. Decline of serum PG I levels and PG I/II ratios correlates with the extent of mucosal atrophy in the gastric corpus and gastric acid secretion ability. Stepwise reduction of the PG I/II ratio is closely correlated with the progression from normal gastric mucosa to extensive atrophic gastritis. (54)(55)

The risk of gastric cancer incidence, especially intestinal type, depends on advancement of atrophic gastritis. Serum PG level is considered a useful marker of atrophic gastritis, which is a precancerous change in the stomach. Mass screening of high-risk patients with gastric cancer using the PG method was introduced to detect gastric cancer following endoscopic examination. Positive PG method that are PG I ≤ 70ng/l and PG I/II ratio ≤ 3.0 indicates high risk of gastric cancer. Prospective cohort studies also confirmed that PG method is useful for assessing gastric cancer risk. (56)-(58) A case-control study on the

effect of gastric cancer screening using the PG method showed the odds ratios for death from gastric cancer among control subjects screened within 1 and 2 years were 0.238 (0.061-0.929) and 0.375 (0.155-0.905), respectively. (59) Gastric cancer screening using the pepsinogen method was suggested to reduce mortality from gastric cancer.

The ABC(D) stratification using both anti-*H. pylori* antibody and serum PG levels allows classification of gastric cancer risk into the following groups based on these levels: Group A is negative for both PG method results and the antibody, Group B is negative for PG method results and positive for the antibody, Group C is positive for both PG method results and the antibody, and Group D that is positive for PG method results and negative for the antibody. With the progression of H. pylori-induced gastritis, the risk of gastric cancer increased in a stepwise fashion from Group B (HR=7.13, 95%CI=0.95-53.33) to Group C (HR=14.85, 95%CI=1.96-107.7) and finally to Group D (HR=61.85, 95%CI=5.6-682.64). (60) In another result, Group C had a moderately high hazard ratio of 11.23, while Group D had a markedly higher hazard ratio of 14.81. (61) Therefore, these two groups are considered the most appropriate candidates for gastric cancer screening. Recently, ABC(D) stratification has spread as a new method of gastric cancer screening (Table 5). Because of the high risk of gastric cancer, endoscopic examination is recommended every year for Group D, every two years for Group C, every three years for Group B, and every five years for Group A. (62)

Strategy of eliminating gastric cancer

According to Asia-Pacific consensus guidelines, a population 'test and treat' strategy for *H. pylori* infection in communities with high incidence of gastric cancer such as Japan and Korea is considered to be an effective strategy for gastric cancer prevention. (63)(64) The Japanese Society for *Helicobacter* Research has published a guideline recommending that *H. pylori* infection be treated with eradication therapy. (65) Strategy of test and treat for *H. pylori* infection is effective at reducing the incidence and mortality of gastric cancer in communities with high incidence of gastric cancer. However, follow-up surveillance for gastric cancers was necessary after successful eradication of *H. pylori*, because the risk of cancer persists for long after cure of *H. pylori*. Therefore, strategy of test, treat and screening that combines primary and secondary prophylaxis is the most important to reach the final goal of eliminating gastric cancer in Japan.

We have proposed a program of risk stratification (ABC stratification) based on the presence of *H. pylori* infection with or without atrophic gastritis followed by targeted interventions. (66) (Figure 1) Those at no risk for gastric cancer (no *H. pylori*, no atrophic gastritis) need no therapy or follow-up. Those at low risk (*H. pylori* infected, non-atrophic gastritis) need only *H. pylori* eradication therapy. The smaller groups at high or very high risk need eradication and cancer surveillance using endoscopic examination. We estimated the costs and the benefits of this strategy markedly reduce the cost of treating gastric cancer in spite of initially increasing national healthcare expenditure. In Japan, about 3 billion

dollars are spent annually on the treatment of gastric cancer. (67) The annual cost will probably exceed 5 billion dollars after 10 years if effective strategy of gastric cancer prevention are not taken. Theoretically, eradication of *H. pylori* in all carriers could prevent about 150 000 deaths from gastric cancer during the subsequent 5 years. (68) The program of gastric cancer prevention is expected to induce reduction in costs consumed by *H. pylori*-related diseases.

One week of triple therapy using a proton pump inhibitor (PPI) combined with amoxicillin (AMPC) and clarithromycin (CAM) is used as the first-line treatment for eradicating *H. pylori* in Japan. If the first-line treatment is failed, one week of triple therapy including PPI, AMPC, and metronidazole (MNZ) is used as the second-line rescue treatment. Overall eradication rate of first and second-line treatment is currently 97-98 %. Because adverse events are mainly soft stools and diarrhea, the safety of *H. pylori* eradication treatment is proved.

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Table 1. Japanese cohort studies of *H. pylori* eradication and gastric cancer development

Author	Year	n Disease	Group	Follow (yrs)	Incident rate of GCA(%)	Incident rate per year(%)	Significance (per protocol)
Take	2005	1342	C	3.4	4/176 (2.3)	0.68	P<0.01
		GU/DU	E	3.4	8/944 (0.8)	0.24	
Takenaka	2007	1807	C	2.9	5/288 (1.7)	0.59	P<0.05
		GU/DU	E	3.3	6/1519 (0.4)	0.12	
Ogura	2008	708	C	3.1	13/304 (4.3)	1.40	P<0.01
		GU/DU	E	3.2	6/404 (1.5)	0.47	
Yanaoka	2009	4141	C	9.3	55/3658 (1.5)	0.16	n.s
		Healthy	E	9.3	5/473 (1.1)	0.12	
Mabe	2009	4133	C	5.2	9/352 (2.6)	0.50	P<0.05
		GU/DU	E	5.6	47/3781 (1.2)	0.21	

GU: Gastric ulcer DU: duodenal ulcer C: Control E: Eradication GCA: gastric cancer

Table 2 Randomized controlled studies of *H. pylori* eradication and gastric cancer development

Author	Year	n Disease	Follow (yrs)	Group	Incident rate of GCA(%)	Incident rate per year(%)	Significance
Correa	2000	967 Healthy	6	C E	2/485 (0.4) 3/491 (0.6)	0.07 0.10	n.s.
Wong	2004	1807 Healthy	7.5	C E	11/813 (1.4) 7/817 (0.9)	0.18 0.11	n.s.
You	2006	2258 Healthy	7.3	C E	27/1128 (2.4) 19/1130 (1.7)	0.33 0.23	n.s.
Saito	2005	692 Healthy	4	C E	3/313 (1.0) 2/379 (0.5)	0.24 0.13	n.s.
Zhou	2008	552 Healthy	8	C E	7/276 (2.5) 2/276 (0.7)	0.32 0.09	n.s.
Fukase	2008	505 Resected GCA	3	C E	24/255 (9.4) 9/250 (3.6)	3.1 1.2	P<0.01

Table 3 Incidence rate of gastric cancer and sample size

	Primary Gastric cancer	Metachronous Gastric cancer
Subjects	*H. pylori* positive	*H. pylori* positive After endoscopic resection of primary cancer
Incident rate/year		
Control group	0.2-0.4%	3-5%
Eradication group	0.1-0.2%	1-2%
Sample size	10000	500
Follow-up period	10 yrs	3 yrs

Table 4 Method of gastric cancer screening

	Photofluography	Endoscopy	Pepsinogen
Indication	Population-based	Opportunistic	Population-based
Secondary Screening	Endoscopy	Not necessary	Endoscopy
Participants	About 6390,000	About 210,000	About 500,000
Detection rate of gastric cancer	0.088%	0.30%	0.44%
Evidence of mortality reduction	Case-control study Meta-analysis	Case-control study	Case-control study
Level of evidence (Minds)	Evidence level IVa	Evidence level IVa	Evidence level IVa