Defining Strategies for Peptic Ulcer Treatment: A *Helicobacter pylori* Economic Cost Model

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ABSTRACT: This article describes an economic model for evaluating *Helicobacter pylori* (*H. pylori*) eradication and conventional treatment of peptic ulcer disease. The model was developed using decision analytic techniques with literature-based estimates of probabilities, cost, and population sizes. One-way sensitivity analysis was conducted varying costs and probabilities over relevant ranges. Decision points used in the model include endoscopy, tests for *H. pylori* presence, and use of maintenance therapy. Chance relationships include probabilities of ulcer, presence of *H. pylori*, eradication of *H. pylori*, success of treatment, compliance, and recurrence. The outcome measure is first-year cost of peptic ulcer management.

Results support the use of *H. pylori* eradication. Savings depend on the rate of endoscopy and expense of eradication therapies. The model suggests that costs may be reduced if patients with a prior history of ulcer are targeted for empiric *H. pylori* eradication therapy.

Our findings suggests a three-stage approach to treating peptic ulcer disease if first-year costs are considered. Patients who initially present with symptoms consistent with ulcer should be treated with conventional therapy. If one or more recurrences are experienced, then ulcer diagnosis can be considered as substantiated and *H. pylori* eradication is indicated. Endoscopy should be conducted if more serious disease is suspected or if patient is nonresponsive to conventional or *H. pylori* eradication therapies. Managed care organizations should develop and communicate ulcer management strategies that consider both eradication and conventional treatment.

KEY WORDS: Economic, Ulcer, *H. pylori* model, Disease state management

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This article develops a literature-based cost model for *Helicobacter pylori* (*H. pylori*) eradication and contrasts it with a conventional treatment model for ulcer disease. An understanding of *H. pylori* eradication program costs is important because the National Institutes of Health consensus development panel recommends *H. pylori* eradication as a first-line therapy for treatment of duodenal ulcer.¹

Several economic models have demonstrated the effect of *H. pylori* eradication on ulcer recurrence, compared the use of endoscopic testing versus empiric therapy, and compared alternative pharmaceutical therapies.²⁻⁷ This model differs from other published models by estimating the total cost of peptic ulcer treatment for various treatment strategies in selected patient populations. The proposed cost-analysis model provides a theoretical basis for forecasting costs of an *H. pylori* eradication program. Many managed care organizations (MCOs) develop and implement disease state management programs with the expectation that such programs will lower treatment costs while maintaining or improving the quality of care. This model gives MCOs a method to estimate peptic ulcer treatment costs for different treatment strategies in their patient populations, using their databases.

Increased understanding of peptic ulcer disease and *H. pylori* infection has led to the development of pharmaceutical

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Table 1. Patient Groups for Whom Population Size Estimates Are Needed

- ▲ New patients (no history of ulcer/not on maintenance therapy)
- ▲ Existing patients with history of ulcer/on maintenance therapy
- ▲ Existing patients with history of ulcer/not on maintenance therapy
- ▲ Existing patients with no history of ulcer/on maintenance therapy
- ▲ Existing patients with no history of ulcer/not on maintenance therapy

therapies with the potential to cure the disease, thereby eliminating the costs of ulcer recurrence. Potential savings from improvements in ulcer treatment are intuitively obvious; however, the potential costs of treatment may not be as clear. For example, if program implementation results in increased use of diagnostic procedures, such as endoscopy and *H. pylori* presence tests, costs will increase. Unneeded costs may be incurred if patients who are not appropriate candidates for therapy are treated. Literature suggests there is no evidence that patients who have nonulcer dyspepsia (gastritis) should be treated with *H. pylori* eradication therapy.² More research is needed to document this supposition. Clinically acceptable and economically favorable treatment of peptic ulcer disease may be enhanced by management strategies such as targeting patients who should receive diagnostic tests, improving patient medication compliance, and choosing between *H. pylori* eradication and conventional ulcer treatment. The proposed model attempts to elucidate the economic consequences of various treatment strategies.

MODEL COMPONENTS AND ASSUMPTIONS

The model covers a 12-month period. An *H. pylori* eradication program that eliminates the need for maintenance therapy will result in savings that exceed those in the one-year model presented. Furthermore, the model assumes that the

population size within the MCO is constant over the period modeled. Being literature-based, the model may not reflect actual costs or disease prevalence within a particular MCO, but it should provide a general framework for analysis. Using these assumptions, the model was developed in four stages:

- ▲ estimation of population size for *H. pylori* eradication and conventional therapy cost comparisons;
- ▲ development of a decision tree to model the flow of major decisions, chance events, and outcomes associated with *H. pylori* eradication and conventional ulcer treatment;
- ▲ assignment of probabilities and costs to the events and outcomes for each path of the decision tree; and
- ▲ sensitivity analysis for key analysis variables.

Model specification begins by stipulating four key treatment decisions. The first decision involves using endoscopy to verify an ulcer diagnosis versus using empiric therapy (decision 1). This diagnostic decision exists for both the conventional and *H. pylori* eradication treatment arms of the model. In the case of *H. pylori* eradication, if endoscopy was performed, the assumption was that a biopsy or serum test for *H. pylori* would also have been conducted.

A second critical decision was whether to include serum testing for the presence of *H. pylori* before (decision 2) and after (decision 3) empiric therapy to determine if eradication therapy was successful. Finally, a maintenance therapy decision node was included in the conventional arm (decision 4).

This combination of decisions presents seven possible scenarios for *H. pylori* eradication patients and 13 possible scenarios for conventional therapy patients. Within each of these scenarios, several pathways could be followed based on diagnostic test results, therapy success or failure, and whether (for the conventional model) patients were placed on maintenance therapy.

Decisions regarding *H. pylori* eradication or conventional treatment differ among patient groups (e.g., use of endoscopy, eradication tests, maintenance therapy). To account for this

Table 2. Decision Scenarios and Outcome Pathways for the *H. pylori* Eradication Portion of the Model

Scenario Number	Endoscopy and Biopsy or Serum Test	Serum Test Only	Eradication Test	Number of Possible Outcomes or Pathways
Scenarios for New or Existing Patients Without Documented History of Ulcer				
Scenario 1	YES	NO	YES	5
Scenario 2	YES	NO	NO	4
Scenario 3	NO	YES	YES	5
Scenario 4	NO	YES	NO	4
Scenario 5	NO	NO	NO	3
Scenarios for Existing Patients With Documented History of Ulcer				
Scenario 6	NO	NO	YES	4
Scenario 7	NO	NO	NO	3

variation, five patient groups were identified (see Table 1). These patient groups were selected because recurrence rates and treatment needs are likely to differ among them. For example, a new patient (i.e., no prior history of complaint) may be more likely to undergo diagnostic testing than an existing patient on maintenance therapy. Also, patients on maintenance therapy should be less likely to experience recurrence than patients who do not receive maintenance therapy.

New patients, by definition, have no history of ulcer and are not on maintenance therapy. Existing patients are identified by prior use of acute-level dosing of an antiulcer medication. History of ulcer is defined either by previous endoscopy or by the number of recurrences of acute therapy a patient has experienced (an MCO's database should have data to identify both inclusion criteria). For example, patients who have received three courses of acute therapy (i.e., three courses of acute-level dosing, each lasting six to eight weeks) over a two-year period are assumed to have a history of ulcer even if an endoscopic procedure was not performed. Using this logic, a patient without a documented history of ulcer could be classified as an existing ulcer patient. This could occur when a patient has received two courses of acute therapy and has no evidence of endoscopy. Tables 2 and 3 present the scenarios and possible pathways for *H. pylori* eradication and conventional treatment for the patient groupings listed in Table

1. Note that for the *H. pylori* eradication arm of the model, the patient groupings are reduced to two; prior treatment is irrelevant since the approach to eradication is the same in this model. Existing patients without a documented history of ulcer are treated as if they were new patients.

There are multiple pathways for each decision scenario because each decision may have different results. For example, if endoscopy is performed, patients may be either positive or negative for ulcer. The right-hand columns of Tables 2 and 3 show the number of pathways that result from the decisions.

Literature-Based Estimation of Patient Groupings

The next stage in model development is estimation of the population sizes for each of the five patient groups listed in Table 1. The literature did not provide estimates of population sizes for all five groups. When estimates were not available, sample sizes were extrapolated or approximated, based on the opinion of the authors and three clinical pharmacist consultants.

For the purpose of illustrating this model, a managed care population of 100,000 enrollees was assumed. The lifetime prevalence of ulcer disease in the United States is 8%, and approximately 1.8% of the population will experience active ulcer during any year.⁹ This means that at any time a total of

Table 3. Decision Scenarios and Outcome Pathways for the Conventional Portion of the Model

Scenario Number	Endoscopy	Maintenance Therapy	Number of Possible Outcomes or Pathways
Scenarios for New Patients			
Scenario 1	YES	YES	8
Scenario 2	YES	NO	6
Scenario 3	NO	YES	7
Scenario 4	NO	NO	5
Scenarios for Existing Patients with No Documented History of Ulcer Not Currently Using Maintenance Therapy			
Scenario 5	YES	YES	7
Scenario 6	YES	NO	5
Scenario 7	NO	YES	6
Scenario 8	NO	NO	4
Scenarios for Existing Patients with Documented History of Ulcer Currently Using Maintenance Therapy			
Scenario 9	NO	YES	6
Scenarios for Existing Patients with Documented History of Ulcer Not Currently Using Maintenance Therapy			
Scenario 10	NO	YES	6
Scenario 11	NO	NO	4
Scenarios for Existing Patients with No Documented History of Ulcer Currently Using Maintenance Therapy			
Scenario 12	YES	YES	7
Scenario 13	NO	YES	6

Table 4. Group Size Estimates

Group	Number and Percentage of Patients Expected per 100,000 Enrollees	Calculation*
New patients	234 (3%)	$(100,000 \times 0.018 \times 0.13)$
Existing patients on maintenance therapy with ulcer history	1,635 (20%)	$(1,566 \times 0.75 \times 0.6) + (6,200 \times .25 \times .6)$
Existing patients on maintenance therapy with no ulcer history	1,090 (14%)	$(1,566 \times 0.75 \times 0.4) + (6,200 \times .25 \times .4)$
Existing patients not on maintenance therapy with ulcer history	1,860 (23%)	$(6,200 \times 0.75 \times 0.4)$
Existing patients not on maintenance therapy with no ulcer history	3,181 (40%)	$(1,566 \times 0.25) + (6,200 \times .75 \times .6)$
TOTAL	8,000 (100%)	

*Note: The 1,566 patients were identified using the following calculation: $(8,000 \text{ total patients} \times 0.018 \text{ active}) - (234 \text{ new patients}) = 1,566$. The 6,200 patients were identified using the following calculation: $(100,000 \text{ in population} \times 0.08 \text{ with ulcer disease}) - (1,800) = 6,200$, where 1,800 represents the total number of active ulcer patients in a year $(8,000 \times 0.018) = 1,800$.

8,000 patients in this hypothetical population could be expected to carry an ulcer diagnosis. These 8,000 patients will be distributed among the five patient groups in Table 1. Likewise, the total number of patients (new and existing) with active ulcer within any given year is 1,800 $(100,000 \text{ patients} \times 0.018)$. Peer-reviewed literature suggests that approximately one of every eight patients (13%) with active ulcer during any one-year period will be "first-time" ulcer patients.^{3,9,10} Based on this estimate, there are 234 $(1,800 \text{ patients} \times 0.13)$ new ulcer patients and 7,766 $(8,000 \text{ patients} - 234 \text{ patients})$ who are either "existing active" $(1,800 \times 0.87 = 1,566)$ or "existing but not active" $(7,766 - 1,566 = 6,200)$ ulcer patients. These 7,766 ulcer patients are categorized by whether or not they receive maintenance treatment. Literature reports suggest that approximately 80% of ulcer patients will experience recurrence over a one- to two-year period.¹¹ Accepted ulcer therapy recommends that maintenance therapy should be used upon ulcer recurrence. For the model, we assumed that approximately 75% of "existing active" ulcer patients will be on maintenance therapy and 25% of the "existing but not active" patients will be on maintenance therapy. Finally, patients must be categorized by whether they have a documented history (by endoscopy or number of recurrences) of ulcer. Since there were no data available in the literature for these groups, we estimated that approximately 60% of patients on maintenance therapy would have a history of ulcer based on endoscopy or recurrence, and for those not on maintenance therapy these percentages were reversed (i.e., 40% of nonactive patients not on maintenance will have a history of ulcer). We selected a mid-range value because it is likely that this percentage will vary substantially among organizations due to variations in demographics, case-mix, and types of providers. These percentages were varied in a sensitivity analysis to evaluate their impact on

costs. MCOs may be able to evaluate their paid medical claims data to calculate actual prevalence of ulcer. Table 4 presents the final population size estimates for each patient group.

Decision Tree Models

Because the decision tree is large (84 unique pathways), it cannot be depicted here. However, the decision and chance nodes from the tree are shown in Table 5, and an example of two arms of the tree (one for conventional treatment and one for *H. pylori* eradication) is included in Appendix A. The values of chance variables differed depending on the patient group being modeled. Values for chance variables were determined from the literature, except where assumptions were necessary, as noted in the introduction.

These decision and chance variables can be combined to represent 32 events for the *H. pylori* eradication portion of the model and 96 events for the conventional treatment portion of the model. For example, if the decision is made to conduct endoscopy, the patient may then test positive for ulcer and *H. pylori* and receive treatment, but symptoms do not resolve. Each of these combinations is associated with an event probability.

The probabilities for all chance nodes are presented in Appendix B. To investigate whether changes in the probabilities would affect results, each probability was varied in a one-way sensitivity analysis. The size of the model precludes a discussion here of each pathway.

Evidence from the literature indicates that approximately 20%–25% of subjects who present with dyspeptic symptoms have an ulcer.^{12,13} Therefore, the starting point for the model was that 25% of new patients presenting with ulcer symptoms would be demonstrated by endoscopy to have an ulcer, while 75% would not. This estimate was used in both the *H. pylori* eradication and conventional models.

Walsh and Peterson¹⁴ have reported cure rates with *H.*

Table 5. Decision and Chance Nodes Used in Conventional Treatment and *H. pylori* Eradication Decision Subtree

Variable	Variable Type	Description
<i>H. pylori</i> Eradication Model		
Endoscopy with biopsy	Decision	Conduct test or use empiric therapy
Serum test for <i>H. pylori</i>	Decision	Test or not test after treatment if endoscoped or before and after empiric treatment
Eradication test <i>H. pylori</i>	Decision	Test or not test after treatment
Results of endoscopy and biopsy	Chance	Probability of being positive or negative for <i>H. pylori</i> and ulcer
Results of treatment	Chance	Probability that symptoms return or do not return after treatment or retreatment
Eradication testing	Chance	Probability that <i>H. pylori</i> has been eradicated or not eradicated
Results of <i>H. pylori</i> presence test	Chance	Probability that <i>H. pylori</i> is present or not present
Conventional Model		
Endoscopy	Decision	Conduct test or use empiric therapy
Maintenance therapy	Decision	Use or do not use maintenance therapy
Results of endoscopy	Chance	Probability of being positive or negative for ulcer
Results of acute ulcer treatment	Chance	Probability that symptoms do or do not resolve after treatment or retreatment
Symptom recurrence	Chance	Probability that symptoms do or do not recur after acute treatment or retreatment
Patient medication compliance	Chance	Probability that patients will or will not be compliant

pylori eradication therapies in excess of 90%. The starting values used for "no return of symptoms" was 90% after either treatment or retreatment with eradication therapy for patients who receive endoscopy and 67% for patients who were treated empirically. The difference in cure rate reflects the view that a higher percentage of empirically treated patients will have symptoms that will not be relieved by *H. pylori* eradication treatment (e.g., nonulcer dyspepsia, gastroesophageal reflux disease), thus resulting in a lower symptom resolution percentage.^{15,16} This assumption was based on clinical judgment and not on the literature.

The final set of probabilities in the *H. pylori* eradication model focuses on the use of tests to determine if *H. pylori* is present. The literature suggests that efficacy rates for antibiotic therapy in *H. pylori* eradication treatment are similar for initial treatment and retreatment.¹⁷ Therefore, a value of 90% was used for the probability of a negative test for presence of *H. pylori* following eradication therapy.

A similar, literature-based, approach was used to assign probabilities for the conventional model. The literature suggests that 75%–85% of patients with confirmed ulcer will heal during a four-to-eight-week course of conventional therapy,

and about 60% will recur over the next 12 months if maintenance therapy is not utilized.¹¹ If patients are placed on maintenance therapy and remain compliant, the recurrence rate will be significantly lower. An estimate of 40% was used in the model based on the authors' judgment. This estimate was varied over a wide range in the sensitivity analysis. Conventional wisdom and experience show that a high percentage of patients will be noncompliant; however, there were no estimates in the literature for compliance with antiulcer maintenance therapy. Using clinical judgment, 75% of patients were estimated to be compliant; the effects of variation in this estimate were tested in the sensitivity analysis.

Combining all these events results in 23 pathways for the *H. pylori* eradication model and 61 for the conventional model. Pathways that ended in treatment failure were assumed to be referred, and the cost of referral was included in the cost estimates. Costs beyond referral were not included in the model. The range of cost estimates used in the model and sensitivity analyses are shown in Table 6.

Because the model is estimated for a fixed period, the number of months for which new patients will have an opportunity to use maintenance therapy decreases over time and,

Table 6. Estimated Cost Ranges for *H. pylori* Eradication and Conventional Treatment

Description	Cost Range
<i>H. pylori</i> Eradication	
Endoscopy	\$300–\$2,000
<i>H. pylori</i> presence test when conducted with endoscopy (either by biopsy or titer)	\$50–\$300
<i>H. pylori</i> eradication therapy	\$50–\$200
<i>H. pylori</i> eradication test (urea breath test)	\$50–\$300
Referral to physician outside <i>H. pylori</i> eradication program (for treatment failures)	\$50–\$400
Second course of <i>H. pylori</i> eradication therapy	\$50–\$200
<i>H. pylori</i> presence test (serum only, including titer, not biopsy)	\$50–\$300
<i>H. pylori</i> eradication test (serum only, including titer, not biopsy)	\$50–\$300
Conventional Treatment	
Endoscopy	\$300–\$2,000
Acute ulcer therapy (8 weeks)	\$50–\$200
Maintenance therapy (1 month)	\$30–\$150
Referral to physician outside conventional treatment program (for treatment failures)	\$50–\$400
Cost of a physician office visit for recurrence	\$20–\$100

therefore, the differential effects of time must be included. In addition, existing patients who are on maintenance therapy and develop an active ulcer will revert to acute-level dosing. Costs for maintenance therapy will be adjusted to reflect this change in dosing. Acute therapy may vary from one to three months.

A compliance factor was also included because patients who may be considered compliant are likely to have some variation in use and noncompliant patients probably use some medication. Finally, patients experiencing recurrence will have different numbers of episodes. For example, existing patients on maintenance therapy are likely to experience a lower number of recurrences per year, on average, than existing patients who are not on maintenance therapy. These modifications to the cost calculations of Table 6 are presented in Table 7.

Cost estimates for the *H. pylori* eradication and conventional models were developed by applying the formulas below to each pathway. Where a parameter is not applicable, its contribution is zero.

Table 7. Factors Used in Cost Calculations

Factor	Range of Values
Maintenance therapy	2.0–5.5 months for new patients 12 months for existing patients on maintenance 4.5–10 months for existing patients not on maintenance
Acute therapy	1–3 months
Compliance	60%–100% for compliant patients 0% to 50% for noncompliant patients
Number of recurrences	0 No recurrence 1–Single recurrence 1.0–2.0 for multiple recurrences

***H. pylori* Eradication Cost Formula**

Cost for pathway = endoscopy + (*H. pylori* test) + (*H. pylori* eradication therapy) + (*H. pylori* eradication test) + (second course of *H. pylori* eradication therapy) + (cost of referral if therapy fails).

Conventional Therapy Cost Formula

Cost for pathway = endoscopy + (initial acute ulcer treatment) + (acute ulcer treatment)(number of recurrences) + (average cost of maintenance)(maintenance factor)(compliance)–(number of recurrences)(acute factor)(average cost of maintenance therapy)(compliance) + (cost of physician visit)(number of recurrences) + (cost of referral if treatment fails).

RESULTS AND DISCUSSION

Tables 8 and 9 present the results for the *H. pylori* eradication and conventional portions of the model. The model allows users to specify the percentage of patients who will follow each scenario. For example, in the conventional model, 30% of the patients were estimated to follow scenarios one and four while 20% would follow scenarios two and three. These decisions were based on clinical judgment. Existing patients on maintenance therapy with a history of ulcer have only one scenario because none of these patients receive endoscopy and continue on maintenance therapy after a recurrence. Tables 8 and 9 may be entered into spreadsheets, and the sensitivity of the model to the effects of moving patients from one category to another can be simulated. In this manner, effects such as induced demand for endoscopy if an *H. pylori* eradication program is implemented versus continuing with conventional therapy could be incorporated.

Under the assumptions made in this model, the results suggest that implementation of an *H. pylori* eradication pro-

gram has the potential to generate cost savings. Tables 8 and 9 show significant differences in cost depending on the mode of therapy. Though patients who receive endoscopy would be expected to have much higher costs than those who do not receive endoscopy, the model suggests a strategy for achieving similar therapeutic results at a reduced cost. Patients with suspected ulcer disease could be started on conventional therapy. Experiencing one or two recurrences would be considered confirmation of an ulcer diagnosis, and eradication treatment could be employed. This approach avoids the unnecessary expense of antibiotic exposure associated with initial empiric use of *H. pylori* eradication therapy. This finding is not intended to imply that all eradication regimens are costly. From an economic perspective, however, any expenditures that do not result in a positive outcome reduce the cost-effectiveness of a selected alternative.

Sensitivity Analysis

A one-way sensitivity analysis was conducted for each variable. One-way sensitivity analysis varies the probabilities and costs used in the model, one at a time, over some reasonable range. Using this approach, the range of total costs for the *H. pylori* eradication model was \$2.05–\$3.44 million. The two primary cost-drivers were endoscopy and eradication therapy. For the conventional model, total costs ranged from \$1.95–\$4.92 million. The cost-drivers for the conventional model were the probability of symptom recurrence and the cost of maintenance treatment.

A second sensitivity analysis was conducted by estimating the model cost under the assumptions of using the least expensive and most expensive treatment options. Results indicated a range of \$1.3–\$6.8 million for the conventional model and \$1.2–\$7.6 million for the *H. pylori* eradication model. The high estimate for the *H. pylori* eradication model reflects the dominant influence of endoscopy cost in determining total treatment costs. The \$7.6 million estimate is based on using

Table 8. *H. pylori* Eradication Model Cost Estimations

	Costs per Patient	% of Patients	# of Patients	Sum
New patients or existing patients without history (n=4,505)				
Scenario 1	\$1,573.20	0.05	225	\$354,363.30
Scenario 2	\$1,567.50	0.1	451	\$706,158.75
Scenario 3	\$388.37	0.1	451	\$174,960.69
Scenario 4	\$353.45	0.5	2,253	\$796,146.13
Scenario 5	\$177.22	0.25	1,125	\$199,594.03
Existing patients with history of ulcer (n=3,495)				
Scenario 6	\$132.80	0.3	1,048	\$139,240.80
Scenario 7	\$112.00	0.7	2,447	\$274,008.00
Total Costs				\$2,644,471.69

Table 9. Conventional Model Cost Estimations

	Costs per Patient	% of Patients	# of Patients	Sum
New patients (n=234)				
Scenario 1	\$1,258.19	0.3	70	\$88,325.11
Scenario 2	\$1,236.40	0.2	47	\$57,863.45
Scenario 3	\$311.27	0.2	47	\$14,567.32
Scenario 4	\$234.35	0.3	70	\$16,451.23
Existing patients not on maintenance therapy with no history of ulcers (n=3,181)				
Scenario 5	\$1,032.67	0.1	318	\$328,493.53
Scenario 6	\$979.66	0.1	318	\$311,631.12
Scenario 7	\$376.75	0.7	2,227	\$838,911.90
Scenario 8	\$188.27	0.1	318	\$59,889.32
Existing patients on maintenance therapy with history of ulcer (n=1,635)				
Scenario 9	\$307.39	1.0	1,635	\$502,578.07
Existing patients not on maintenance therapy with history of ulcer (n=1,860)				
Scenario 10	\$340.80	0.8	1,488	\$507,104.15
Scenario 11	\$164.66	0.2	372	\$61,255.01
Existing patients on maintenance therapy with no history of ulcer (n=1,090)				
Scenario 12	\$457.61	0.5	545	\$249,397.50
Scenario 13	\$214.92	0.5	545	\$117,134.02
Total Costs				\$3,153,601.74

endoscopy to diagnose ulcer prior to therapy in all eligible patients. While endoscopy for all patients offers the highest degree of specificity, the costs are also high. The lowest-cost estimates are associated with the use of empiric therapy in all potential ulcer patients. Under this situation, one-year costs will be lower; however, the use of antibiotics in patients who may not benefit is a debatable treatment strategy. Based on the sensitivity analysis, first-year costs associated with *H. pylori* eradication cannot be assumed to be lower than those associated with conventional therapy. Results depend on how patients are selected and the treatment pathways they follow. If everyone who might potentially have an ulcer undergoes endoscopy, costs will be greater than if empiric therapy is used. The key to developing a management strategy for peptic ulcer disease is identifying which patients are most likely to benefit from endoscopy and reserving endoscopy for these patients. The model allows assessment of the impact on costs, as well as on cure rates, by considering the percentages of patients sent down each pathway and the numbers entered into the probability of successful treatment.

Table 10. Sensitivity Analysis Results

Analysis Variable	Cost Estimates (\$ in Millions)	
<i>H. pylori</i> Eradication Model		
	Minimum	Maximum
Probability of being positive for <i>H. pylori</i> and ulcer	2.65	2.63
Probability that symptoms do not recur	2.42	3.02
Probability that <i>H. pylori</i> has been eradicated but symptoms persist and patients must be retreated or referred	2.64	2.65
Probability that <i>H. pylori</i> is present (confirmed by test)	2.63	2.66
Cost of endoscopy	2.05	3.20
Cost of <i>H. pylori</i> presence test	2.54	2.71
Cost of <i>H. pylori</i> eradication therapy	2.25	3.44
Cost of <i>H. pylori</i> eradication test (urea breath test)	2.60	2.67
Cost of referral	2.32	3.07
Cost of <i>H. pylori</i> presence test (serum)	2.36	3.07
TOTAL RANGE	2.05	3.44
MODEL ESTIMATE	2.64	
Conventional Model		
Probability that patient is positive for ulcer	3.12	3.21
Probability that symptoms resolve	3.01	3.24
Probability that symptoms do not recur	1.95	4.16
Probability that patient is compliant with maintenance therapy	2.96	3.27
Cost of endoscopy	2.51	3.75
Cost of acute ulcer therapy	2.76	3.94
Cost of maintenance therapy	2.56	4.92
Cost of referral	2.99	3.37
Cost of physician office visit	3.12	3.42
Maintenance factor for new patients	3.15	3.16
Maintenance factor for existing patients on maintenance therapy prior to recurrence	2.98	3.45
Acute factor	3.03	3.28
High compliance	2.89	3.41
Low compliance	3.02	3.24
Recurrence factor for new patients	3.11	3.31
Recurrence rate for existing patients	3.11	3.22
TOTAL RANGE	1.95	4.92
MODEL ESTIMATE	3.15	

Limitations

This model does not explicitly address compliance with *H. pylori* eradication therapy. Instead, compliance is built into the failure rate (i.e., 90% success rate). Effects of compliance on various therapies can be assessed only by changing the failure rate. The model also does not consider additional benefits that may accrue from lowering rates of gastric lymphoma. A relationship between *H. pylori* and gastric lymphoma has been reported in the literature. As the mechanism for this associa-

tion becomes elucidated, this effect may need to be included in the model. This model also does not address the full range of causes of peptic ulcer disease. Ulcers due to nonsteroidal antiinflammatory use or Zollinger-Ellison syndrome are not addressed. The average costs presented in the model may not reflect actual costs for MCOs. Health care organizations that have negotiated endoscopy rates significantly different from the averages used in this model should include their own costs in the model. Finally, costs were assumed to be constant over

the year. As costs change, estimates from the model will vary. Use of actual data rather than literature-based estimates is encouraged.

DISCUSSION AND CONCLUSIONS

H. pylori is now established as the principal cause of chronic gastritis and peptic ulcer disease. The impact of *H. pylori* eradication on clinical and economic outcomes is significant. This article uses modeling techniques to evaluate how treatment decisions affect total predicted costs for different populations of ulcer patients. The potential for preventable costs is significant given that suggested conventional treatment of ulcer includes eight weeks of acute therapy, followed by retreatment with acute therapy and maintenance if the ulcer recurs. The percentage of ulcer patients who will experience at least one recurrence within a two-year period has been estimated at 80%.¹¹ Given the assumptions of our model, an *H. pylori* eradication program has the potential of reducing first-year costs of treating ulcer disease in a managed care population. Furthermore, selection of patients in whom a history of ulcer can be documented without generating a new endoscopy could yield even greater savings. In the short run, *H. pylori* eradication will not affect the rate of occurrence of new ulcers; however, it may have a significant effect on the costs and utilization related to recurrence. Eradication of *H. pylori* is gaining acceptance as a first-line treatment for peptic ulcer disease.

Our findings suggests a three-stage approach to treating peptic ulcer disease when considering first-year costs. Patients who initially present with symptoms consistent with ulcer should be treated with conventional therapy. If one or more recurrences are experienced, then ulcer is likely and *H. pylori* eradication should be indicated. Endoscopy should be conducted if more serious disease is suspected or if patients are nonresponsive to conventional or *H. pylori* eradication therapies. MCOs need to develop and communicate ulcer management strategies that consider both eradication and acute treatment followed by maintenance therapy. If the goal of peptic ulcer disease management is to improve clinical outcomes and lower costs, this model may be used as a basis for consideration of how alternative strategies may be developed for several different ulcer populations.

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1. H. pylori Eradication Model

2. Conventional Model

Appendix B. Events Probabilities for Conventional Therapy

1. New Patients

Name	Description	Probability
Event (AA)	After endoscopy, the probability that the patient is positive for ulcer.	0.25
Event (BB)	After endoscopy, the probability that the patient is not positive for ulcer.	0.75
Event (CC)	After endoscopy and acute treatment, the probability that symptoms resolve.	0.85
Event (DD)	After endoscopy and acute treatment, the probability that symptoms do not resolve.	0.15
Event (EE)	After endoscopy, acute treatment, and resolution of symptoms, the probability that symptoms recur.	0.6
Event (FF)	After endoscopy, acute treatment, and resolution of symptoms, the probability that symptoms do not recur.	0.4
Event (GG)	After endoscopy, acute treatment, resolution of symptoms, recurrence, and retreatment, the probability that symptoms resolve.	0.9
Event (HH)	After endoscopy, acute treatment, resolution of symptoms, recurrence, and retreatment, the probability that symptoms do not resolve.	0.1
Event (II)	After endoscopy, acute treatment, resolution, recurrence, retreatment, resolution, maintenance therapy, the probability that the patient is compliant.	0.75
Event (JJ)	After endoscopy, acute treatment, resolution, recurrence, retreatment, resolution, maintenance therapy, the probability that the patient is not compliant.	0.25
Event (KK)	After endoscopy, acute treatment, resolution, recurrence, retreatment, resolution, and no maintenance therapy, the probability that symptoms recur.	0.8
Event (LL)	After endoscopy, acute treatment, resolution, recurrence, retreatment, resolution, and no maintenance therapy, the probability that symptoms do not recur.	0.2
Event (MM)	After endoscopy, acute treatment, resolution, recurrence, retreatment, resolution, maintenance therapy, and the patient is compliant, the probability that symptoms recur.	0.25
Event (NN)	After endoscopy, acute treatment, resolution, recurrence, retreatment, resolution, maintenance therapy, and the patient is compliant, the probability that symptoms do not recur.	0.75
Event (OO)	After endoscopy, acute treatment, resolution, recurrence, retreatment, resolution, maintenance therapy, and the patient is not compliant, the probability that symptoms recur.	0.75
Event (PP)	After endoscopy, acute treatment, resolution, recurrence, retreatment, resolution, maintenance therapy, and the patient is not compliant, the probability that symptoms do not recur.	0.25
Event (QQ)	After empiric therapy and acute treatment, the probability that symptoms resolve.	0.75
Event (RR)	After empiric therapy and acute treatment, the probability that symptoms do not resolve.	0.25
Event (SS)	After empiric therapy, acute treatment, and resolution of symptoms, the probability that symptoms recur.	0.6
Event (TT)	After empiric therapy, acute treatment, and resolution of symptoms, the probability that symptoms do not recur.	0.4
Event (UU)	After empiric therapy, acute treatment, resolution of symptoms, recurrence, and retreatment, the probability that symptoms resolve.	0.9
Event (VV)	After empiric therapy, acute treatment, resolution of symptoms, recurrence, and retreatment, the probability that symptoms do not resolve.	0.1
Event (WW)	After empiric therapy, acute treatment, resolution, recurrence, retreatment, resolution, maintenance therapy, the probability that the patient is compliant.	0.75
Event (XX)	After empiric therapy, acute treatment, resolution, recurrence, retreatment, resolution, maintenance therapy, the probability that the patient is not compliant.	0.25
Event (YY)	After empiric therapy, acute treatment, resolution, recurrence, retreatment, resolution, and no maintenance therapy, the probability that symptoms recur.	0.8
Event (ZZ)	After empiric therapy, acute treatment, resolution, recurrence, retreatment, resolution, and no maintenance therapy, the probability that symptoms do not recur.	0.2
Event (AAA)	After empiric therapy, acute treatment, resolution, recurrence, retreatment, resolution, maintenance therapy, and the patient is compliant, the probability that symptoms recur.	0.25
Event (BBB)	After empiric therapy, acute treatment, resolution, recurrence, retreatment, resolution, maintenance therapy, and the patient is compliant, the probability that symptoms do not recur.	0.75
Event (CCC)	After empiric therapy, acute treatment, resolution, recurrence, retreatment, resolution, maintenance therapy, and the patient is not compliant, the probability that symptoms recur.	0.75
Event (DDD)	After empiric therapy, acute treatment, resolution, recurrence, retreatment, resolution, maintenance therapy, and the patient is not compliant, the probability that symptoms do not recur.	0.25

* Note: The percentages in the following tables were taken from the literature when available. If no literature was available then the numbers used in these tables reflect the opinions of the authors and their clinical pharmacy consultants.

2. Existing Maintenance Patients

Name	Description	Probability
Event (AB)	For patients with a history of ulcer, the probability that symptoms recur.	0.4
Event (AC)	For patients with a history of ulcer, the probability that symptoms do not recur.	0.6
Event (AD)	For patients with a history of ulcer, whose symptoms recur, the probability that symptoms resolve after acute treatment.	0.9
Event (AE)	For patients with a history of ulcer, whose symptoms recur, the probability that symptoms do not resolve after acute treatment.	0.1
Event (AF)	For patients with a history of ulcer, whose symptoms recur, resolve after acute treatment, are placed on maintenance therapy, the probability that these patients will be compliant.	0.75
Event (AG)	For patients with a history of ulcer, whose symptoms recur, resolve after acute treatment, are placed on maintenance therapy, the probability that these patients will not be compliant.	0.25
Event (AH)	For patients with a history of ulcer, whose symptoms recur, resolve after acute treatment, are placed on maintenance therapy, and are compliant, the probability that symptoms will recur.	0.4
Event (AI)	For patients with a history of ulcer, whose symptoms recur, resolve after acute treatment, are placed on maintenance therapy, and are compliant, the probability that symptoms will not recur.	0.6
Event (AJ)	For patients with a history of ulcer, whose symptoms recur, resolve after acute treatment, are placed on maintenance therapy, and are not compliant, the probability that symptoms will recur.	0.6
Event (AK)	For patients with a history of ulcer, whose symptoms recur, resolve after acute treatment, are placed on maintenance therapy, and are not compliant, the probability that symptoms will not recur.	0.4
Event (BB)	For patients with no history of ulcer, the probability that symptoms recur.	0.3
Event (BC)	For patients with no history of ulcer, the probability that symptoms do not recur.	0.7
Event (BD)	For patients with no history of ulcer, whose symptoms recur, receive endoscopy, the probability that the endoscopy indicates an ulcer.	0.25
Event (BE)	For patients with no history of ulcer, whose symptoms recur, receive endoscopy, the probability that the endoscopy does not indicate an ulcer.	0.75
Event (BF)	For patients with no history of ulcer, whose symptoms recur, who do not receive endoscopy, the probability that symptoms resolve after acute treatment and are placed back on maintenance.	0.8
Event (BG)	For patients with no history of ulcer, whose symptoms recur, who do not receive endoscopy, the probability that symptoms do not resolve after acute treatment.	0.2
Event (BH)	For patients with no history of ulcer, whose symptoms recur, are endoscoped and positive for ulcer, the probability that they resolve after acute treatment and are placed back on maintenance therapy.	0.9
Event (BI)	For patients with no history of ulcer, whose symptoms recur, are endoscoped and positive for ulcer, the probability that they do not resolve after acute treatment.	0.1
Event (BJ)	For patients with no history of ulcer, whose symptoms recur, are not endoscoped, resolve after acute treatment, are placed on maintenance therapy, the probability that these patients will be compliant.	0.75
Event (BK)	For patients with no history of ulcer, whose symptoms recur, are not endoscoped, resolve after acute treatment, are placed on maintenance therapy, the probability that these patients will be noncompliant.	0.25
Event (BL)	For patients with no history of ulcer, whose symptoms recur, are endoscoped and positive for ulcer, resolve after acute treatment, are placed on maintenance therapy, the probability that these patients will be compliant.	0.75
Event (BM)	For patients with no history of ulcer, whose symptoms recur, are endoscoped and positive for ulcer, resolve after acute treatment, are placed on maintenance therapy, the probability that these patients will not be compliant.	0.25
Event (BN)	For patients with no history of ulcer, whose symptoms recur, are not endoscoped, resolve after acute treatment, are placed back on maintenance therapy, are compliant, the probability that symptoms will recur.	0.4
Event (BO)	For patients with no history of ulcer, whose symptoms recur, are not endoscoped, resolve after acute treatment, are placed back on maintenance therapy, are compliant, the probability that symptoms will not recur.	0.6
Event (BP)	For patients with no history of ulcer, whose symptoms recur, are not endoscoped, resolve after acute treatment, are placed back on maintenance therapy, are not compliant, the probability that symptoms will recur.	0.6
Event (BQ)	For patients with no history of ulcer, whose symptoms recur, are not endoscoped, resolve after acute treatment, are placed back on maintenance therapy, are not compliant, the probability that symptoms will not recur.	0.4
Event (BR)	For patients with no history of ulcer, whose symptoms recur, are endoscoped and positive for ulcer, resolve after acute treatment, are placed on maintenance therapy, are compliant, the probability that symptoms will recur.	0.4

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2. Existing Maintenance Patients (*continued*)

Name	Description	Probability
Event (BS)	For patients with no history of ulcer, whose symptoms recur, are endoscoped and positive for ulcer, resolve after acute treatment, are placed on maintenance therapy, are compliant, the probability that symptoms will not recur.	0.6
Event (BT)	For patients with no history of ulcer, whose symptoms recur, are endoscoped and positive for ulcer, resolve after acute treatment, are placed on maintenance therapy, are not compliant, the probability that symptoms will recur.	0.6
Event (BU)	For patients with no history of ulcer, whose symptoms recur, are endoscoped and positive for ulcer, resolve after acute treatment, are placed on maintenance therapy, are not compliant, the probability that symptoms will not recur.	0.4

3. Existing Patients Not on Maintenance Therapy

Name	Description	Probability
Event (CB)	For patients with a history of ulcer, the probability that symptoms recur.	0.6
Event (CC)	For patients with a history of ulcer, the probability that symptoms do not recur.	0.4
Event (CD)	For patients with a history of ulcer, whose symptoms recur, the probability that symptoms resolve after acute treatment.	0.9
Event (CE)	For patients with a history of ulcer, whose symptoms recur, the probability that symptoms do not resolve after acute treatment.	0.1
Event (CF)	For patients with a history of ulcer, whose symptoms recur, resolve after acute treatment, are placed on maintenance therapy, the probability that these patients will be compliant.	0.75
Event (CG)	For patients with a history of ulcer, whose symptoms recur, resolve after acute treatment, are placed on maintenance therapy, the probability that these patients will not be compliant.	0.25
Event (CH)	For patients with a history of ulcer, whose symptoms recur, resolve after acute treatment, are not placed on maintenance therapy, the probability that these symptoms will recur.	0.8
Event (CI)	For patients with a history of ulcer, whose symptoms recur, resolve after acute treatment, are not placed on maintenance therapy, the probability that these symptoms will not recur.	0.2
Event (CJ)	For patients with a history of ulcer, whose symptoms recur, resolve after acute treatment, are placed on maintenance therapy, and are compliant, the probability that symptoms will recur.	0.4
Event (CK)	For patients with a history of ulcer, whose symptoms recur, resolve after acute treatment, are placed on maintenance therapy, and are compliant, the probability that symptoms will not recur.	0.6
Event (CL)	For patients with a history of ulcer, whose symptoms recur, resolve after acute treatment, are placed on maintenance therapy, and are not compliant, the probability that symptoms will recur.	0.6
Event (CM)	For patients with a history of ulcer, whose symptoms recur, resolve after acute treatment, are placed on maintenance therapy, and are not compliant, the probability that symptoms will not recur.	0.4
Event (DB)	For patients with no history of ulcer, the probability that symptoms recur.	0.7
Event (DC)	For patients with no history of ulcer, the probability that symptoms do not recur.	0.3
Event (DD)	For patients with no history of ulcer, whose symptoms recur, receive endoscopy, the probability that the endoscopy indicates an ulcer.	0.25
Event (DE)	For patients with no history of ulcer, whose symptoms recur, receive endoscopy, the probability that the endoscopy does not indicate an ulcer.	0.75
Event (DF)	For patients with no history of ulcer, whose symptoms recur, who do not receive endoscopy, the probability that symptoms resolve after acute treatment.	0.8
Event (DG)	For patients with no history of ulcer, whose symptoms recur, who do not receive endoscopy, the probability that symptoms do not resolve after acute treatment.	0.2
Event (DH)	For patients with no history of ulcer, whose symptoms recur, are endoscoped and positive for ulcer, the probability that they resolve after acute treatment.	0.9
Event (DI)	For patients with no history of ulcer, whose symptoms recur, are endoscoped and positive for ulcer, the probability that they do not resolve after acute treatment.	0.1
Event (DJ)	For patients with no history of ulcer, whose symptoms recur, are not endoscoped, resolve after acute treatment, are placed on maintenance therapy, the probability that these patients will be compliant.	0.75
Event (DK)	For patients with no history of ulcer, whose symptoms recur, are not endoscoped, resolve after acute treatment, are placed on maintenance therapy, the probability that these patients will not be compliant.	0.25

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3. Existing Patients Not on Maintenance Therapy (continued)

Name	Description	Probability
Event (DL)	For patients with no history of ulcer, whose symptoms recur, are not endoscoped, resolve after acute treatment, are not placed on maintenance therapy, the probability that these symptoms will recur.	0.6
Event (DM)	For patients with no history of ulcer, whose symptoms recur, are not endoscoped, resolve after acute treatment, are not placed on maintenance therapy, the probability that these symptoms will not recur.	0.4
Event (DN)	For patients with no history of ulcer, whose symptoms recur, are endoscoped and positive for ulcer, resolve after acute treatment, are placed on maintenance therapy, the probability that these patients will be compliant.	0.75
Event (DO)	For patients with no history of ulcer, whose symptoms recur, are endoscoped and positive for ulcer, resolve after acute treatment, are placed on maintenance therapy, the probability that these patients will not be compliant.	0.25
Event (DP)	For patients with no history of ulcer, whose symptoms recur, are endoscoped, resolve after acute treatment, are not placed on maintenance therapy, the probability that these symptoms will recur.	0.6
Event (DQ)	For patients with no history of ulcer, whose symptoms recur, are endoscoped, resolve after acute treatment, are not placed on maintenance therapy, the probability that these symptoms will not recur.	0.4
Event (DR)	For patients with no history of ulcer, whose symptoms recur, are not endoscoped, resolve after acute treatment, are placed on maintenance therapy, are compliant, the probability that symptoms will recur.	0.4
Event (DS)	For patients with no history of ulcer, whose symptoms recur, are not endoscoped, resolve after acute treatment, are placed back on maintenance therapy, are compliant, the probability that symptoms will not recur.	0.6
Event (DT)	For patients with no history of ulcer, whose symptoms recur, are not endoscoped, resolve after acute treatment, are placed back on maintenance therapy, are not compliant, the probability that symptoms will recur.	0.6
Event (DU)	For patients with no history of ulcer, whose symptoms recur, are not endoscoped, resolve after acute treatment, are placed back on maintenance therapy, are not compliant, the probability that symptoms will not recur.	0.4
Event (DV)	For patients with no history of ulcer, whose symptoms recur, are endoscoped and positive for ulcer, resolve after acute treatment, are placed on maintenance therapy, are compliant, the probability that symptoms will recur.	0.4
Event (DW)	For patients with no history of ulcer, whose symptoms recur, are endoscoped and positive for ulcer, resolve after acute treatment, are placed on maintenance therapy, are compliant, the probability that symptoms will not recur.	0.6
Event (DX)	For patients with no history of ulcer, whose symptoms recur, are endoscoped and positive for ulcer, resolve after acute treatment, are placed on maintenance therapy, are not compliant, the probability that symptoms will recur.	0.6
Event (DY)	For patients with no history of ulcer, whose symptoms recur, are endoscoped and positive for ulcer, resolve after acute treatment, are placed on maintenance therapy, are not compliant, the probability that symptoms will not recur.	0.4

Appendix C. Events Probabilities for H. pylori Eradication Therapy

1. New or Existing Patients Without Ulcer History

Name	Description	Probability
Event (A)	After endoscopy and test for presence of <i>h.pylori</i> , the probability of being positive for <i>h.pylori</i> and ulcer or gastritis.	0.25
Event (B)	After endoscopy and test for presence of <i>h.pylori</i> , the probability of being either: 1) negative for <i>h.pylori</i> and positive for ulcer, 2) positive for <i>h.pylori</i> and negative for ulcer, or 3) negative for <i>h.pylori</i> and ulcer.	0.75
Event (C)	After endoscopy, positive test, and eradication therapy, the probability that symptoms do not recur.	0.9
Event (D)	After endoscopy, positive test, and eradication therapy, the probability that symptoms recur.	0.1
Event (E)	After endoscopy, positive test, eradication therapy, symptom recurrence, and administration of eradication test, the probability that <i>h.pylori</i> has been eradicated but symptoms still persist.	0.1
Event (F)	After endoscopy, positive test, eradication therapy, symptom recurrence, and administration of eradication test, the probability that <i>h.pylori</i> has been not been eradicated and retreatment for eradication.	0.9
Event (G)	After endoscopy, positive test, and eradication therapy, symptoms recurrence, no eradication test, and retreatment, the probability that symptoms do not recur.	0.9
Event (H)	After endoscopy, positive test, and eradication therapy, symptoms recurrence, no eradication test, and retreatment, the probability that symptoms recur.	0.1
Event (I)	After endoscopy, positive test, eradication therapy, symptom recurrence, and administration of eradication test, indication that <i>h.pylori</i> has been not been eradicated and retreatment for eradication, the probability that symptoms do not recur.	0.9

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1. New or Existing Patients Without Ulcer History (continued)

Name	Description	Probability
Event (J)	After endoscopy, positive test, eradication therapy, symptom recurrence, and administration of eradication test, indication that <i>h.pylori</i> has been not been eradicated and retreatment for eradication, the probability that symptoms recur.	0.1
Event (K)	After ulcer disease is assumed (no endoscopy), and test for presence of <i>h.pylori</i> , the probability that <i>h. pylori</i> is present.	0.65
Event (L)	After ulcer disease is assumed (no endoscopy), and test for presence of <i>h.pylori</i> , the probability that <i>h.pylori</i> is not present.	0.35
Event (M)	After ulcer disease is assumed (no endoscopy), and no test for presence of <i>h.pylori</i> is conducted, the probability that symptoms do not recur.	0.67
Event (N)	After ulcer disease is assumed (no endoscopy), and no test for presence of <i>h.pylori</i> is conducted, the probability that symptoms recur.	0.33
Event (O)	After ulcer disease is assumed (no endoscopy), test for presence of <i>h.pylori</i> , <i>h.pylori</i> is present, and eradication therapy is used, the probability symptoms do not recur.	0.55
Event (P)	After ulcer disease is assumed (no endoscopy), test for presence of <i>h.pylori</i> , <i>h.pylori</i> is present, and eradication therapy is used, the probability symptoms recur.	0.45
Event (Q)	After ulcer disease is assumed (no endoscopy), no test for presence of <i>h.pylori</i> is conducted, symptoms recur, and retreatment, the probability that symptoms do not recur.	0.33
Event (R)	After ulcer disease is assumed (no endoscopy), no test for presence of <i>h.pylori</i> is conducted, symptoms recur, and retreatment, the probability that symptoms recur.	0.67
Event (S)	After ulcer disease is assumed (no endoscopy), test for presence of <i>h. pylori</i> , <i>h. pylori</i> is present, eradication therapy is used, symptoms recur, test for eradication is administered, the probability that <i>h. pylori</i> is eradicated and symptoms persist.	0.9
Event (T)	After ulcer disease is assumed (no endoscopy), test for presence of <i>h. pylori</i> , <i>h. pylori</i> is present, eradication therapy is used, symptoms recur, test for eradication is administered, the probability that <i>h. pylori</i> is not eradicated and retreatment is administered.	0.1
Event (U)	After ulcer disease is assumed (no endoscopy), test for presence of <i>h.pylori</i> is used, symptoms return after eradication therapy, retreatment for eradication is administered, the probability that symptoms do not recur.	0.33
Event (V)	After ulcer disease is assumed (no endoscopy), test for presence of <i>h.pylori</i> is used, symptoms return after eradication therapy, retreatment for eradication is administered, the probability that symptoms recur.	0.67
Event (W)	After ulcer disease is assumed (no endoscopy), test for presence of <i>h.pylori</i> , <i>h.pylori</i> is present, eradication therapy is used, symptoms recur, test for eradication is administered, <i>h.pylori</i> is not eradicated and retreatment is administered, the probability that symptoms do not recur.	0.33
Event (X)	After ulcer disease is assumed (no endoscopy), test for presence of <i>h.pylori</i> , <i>h.pylori</i> is present, eradication therapy is used, symptoms recur, test for eradication is administered, <i>h.pylori</i> is not eradicated and retreatment is administered, the probability that symptoms recur.	0.67

2. Existing Maintenance Patients with Ulcer History

Name	Description	Probability
Event (AA)	For existing patients with a history of ulcer by endoscopy or recurrence and who receive eradication therapy, the probability that symptoms do not recur.	0.9
Event (BB)	For existing patients with a history of ulcer by endoscopy or recurrence and who receive eradication therapy, the probability that symptoms recur.	0.1
Event (CC)	For existing patients with a history of ulcer by endoscopy or recurrence, receive eradication therapy, symptoms recur, they are tested for eradication, the probability that <i>h.pylori</i> is eradicated and symptoms still persist.	0.1
Event (DD)	For existing patients with a history of ulcer by endoscopy or recurrence, receive eradication therapy, symptoms recur, they are tested for eradication, the probability that <i>h.pylori</i> is not eradicated and retreatment is administered.	0.9
Event (EE)	For existing patients with a history of ulcer by endoscopy or recurrence and who receive eradication therapy, symptoms recur, and retreatment is administered, the probability that symptoms do not recur.	0.9
Event (FF)	For existing patients with a history of ulcer by endoscopy or recurrence and who receive eradication therapy, symptoms recur, and retreatment is administered, the probability that symptoms recur.	0.1
Event (GG)	For existing patients with a history of ulcer by endoscopy or recurrence, receive eradication therapy, symptoms recur, they are tested for eradication, <i>h.pylori</i> is not eradicated and retreatment is administered, the probability that symptoms do not recur.	0.9
Event (HH)	For existing patients with a history of ulcer by endoscopy or recurrence, receive eradication therapy, symptoms recur, they are tested for eradication, <i>h.pylori</i> is not eradicated and retreatment is administered, the probability that symptoms recur.	0.1