COST-EFFECTIVENESS ANALYSIS OF MEDICAL AND SURGICAL TREATMENT FOR DUODENAL ULCER IN SINGAPORE

J Y Kang, T P Lim

ABSTRACT

A mathematical model involving transitions between possible states of duodenal ulcer was used to calculate the costs of various treatments, medical and surgical, which are available for the long-term management of duodenal ulcer. Costs of medical and surgical treatment were based on costs incurred at the National University Hospital, Singapore as at 1990. Elective surgery incurs a high cost, both financial and in terms of mortality, at the outset with minimal additional costs subsequently. The various medical options cost less initially but their costs are cumulative and eventually overtake the costs of surgical treatment. These calculations are based on the use of a proprietary preparation of a histamine-2-blocker. If a generic preparation is used, medical treatment becomes considerably cheaper over a 15 year period.

Keywords: Proximal vagotomy; histamine-2-blocker; ranitidine; cimetidine; maintenance treatment.

SINGAPORE MED J 1991; Vol 32: 225-229

Duodenal ulcer is a chronic recurring disease. A four-week course of histamine-2 blockers is currently the treatment of choice for the acute ulcer episode. It will result in healing in approximately 77%[1] of cases. Several options are however available for long-term management (Fig 1). The patient can stop treatment and await symptomatic relapse when a further four-week course of histamine-2 blockers can be given. The patient can go on maintenance treatment with histamine-2 blockers, usually at half the healing dose. The other alternative is elective surgery, proximal vagotomy being the operation of choice currently.

Each of these options may be indicated in a particular clinical context. For example, a patient who develops one uncomplicated ulcer episode every one or two years would be most suited to go on the intermittent regime. The patient who repeatedly presents with haemorrhage would be better advised to go on maintenance treatment or surgery. For many patients, however, each of the strategies may be equally appropriate. The choice of treatment will then depend in part on doctor and patient preference and in part on cost. Sonnenberg[2] calculated the cost of each strategy in terms of the incidence of complications, death and time lost from work as well as in monetary terms for USA and West Germany. The costs of these strategies vary from country to country. We have therefore repeated his calculations using our local figures for the costs of medication, surgery and time lost from work.

METHODS

Transition Probabilities

Any patient with duodenal ulcer may be considered to be in one of the following states : healed ulcer, recurrent ulcer, post-operative state and dead. Apart from elective surgery as primary treatment of the ulcer disease, severe complications like massive haemorrhage or perforation also require surgical intervention. The post-operative state may be either satisfactory or unsatisfactory (Visick grade 4)[3].

The transition between these states are determined by the probability of ulcer relapse, ulcer healing, requirement for emergency operation, and the outcome of surgery either satisfactory, unsatisfactory or death. The analysis is started with 1000 patients with healed ulcer. Every month patients are redistributed among the various states according to probabilities shown in Table I calculated from data available in the literature[1, 4-7, 9-15].

Cost of Treatment

The costs of ulcer treatment were based on current costs at the National University Hospital for a patient staying in a four-bedded ward. We understand that of the three ward classes available hospital charges for this category of patients is closest to the actual costs of medical care. Ranitidine 150 mg bd for four weeks was considered optimal treatment for the acute episode and 150 mg every night for maintenance. An incidental cost of one week of absenteeism was added for every ulcer relapse. Costs arising from absenteeism and death were based on the mean income of all working persons above the age of ten according to the Department of Statistics, Singapore.

The costs of proximal vagotomy, and in the case of emergency surgery for complications, partial gastrectomy, were estimated from actual costs incurred by patients undergoing these respective operations at our hospital. Visick grade 4 was taken to cause an income loss of 10%[2]. Future costs were discounted by 3% per year[4].

Sensitivity Analysis

Sensitivity analysis was performed to determine the extent that changes in various assumptions affect the costs. We have varied the monthly recurrence rates under maintenance therapy and after surgery between 0.25% and 4%, and between 0.1% and 1%, respectively. Monthly healing rates under maintenance therapy was varied between 70% and 84%, while mortality rates due to proximal vagotomy and frequency of unsatisfactory post-surgical outcomes were varied between 0.15% and 1.2%, and between 2% and 8%, respectively. We have also varied the yearly discount rates on future costs between 2% and 10%.

RESULTS

Based on the assumptions in Table I, the average costs per

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Fig 1 - Therapeutic options for the management of recurrent duodenal ulcer and their outcomes

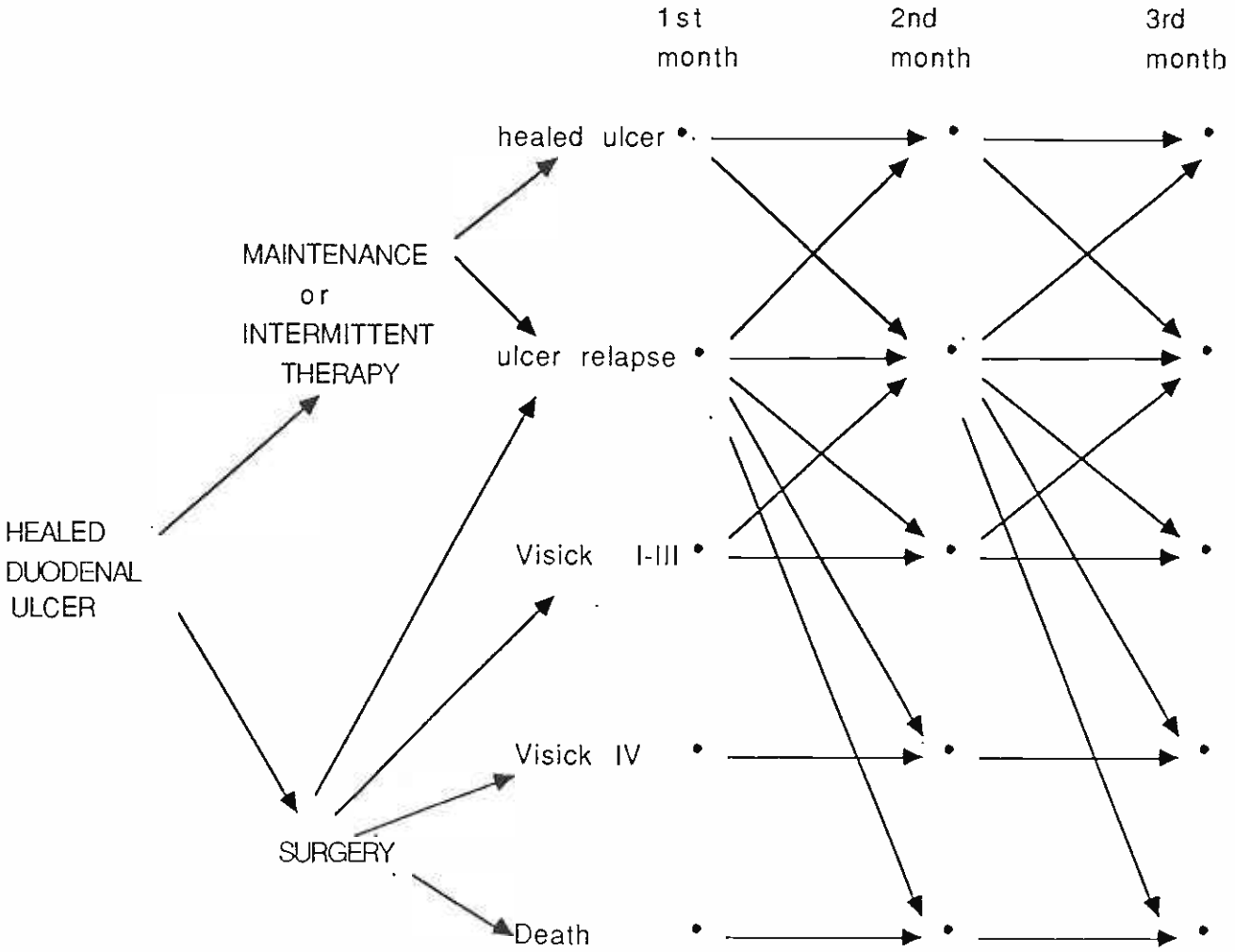


Fig 2 - Cost of different strategies for management of duodenal ulcer (medical treatment using ranitidine)

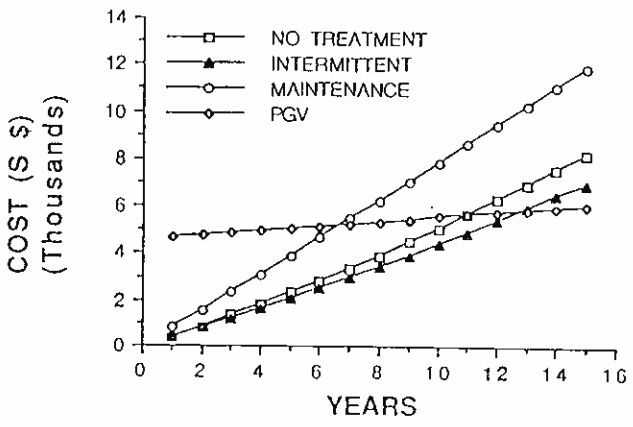


Fig 3 - Mortality rates from duodenal ulcer using different management strategies

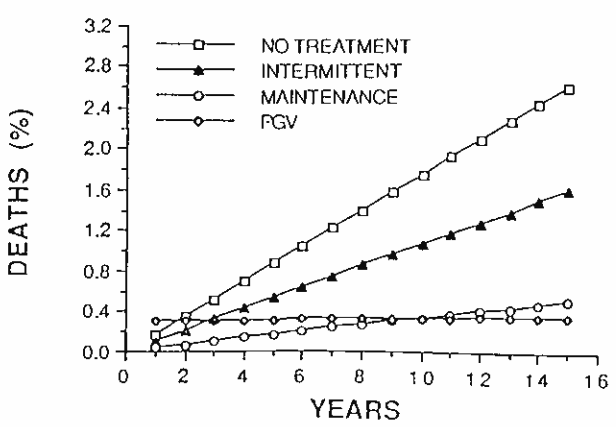


Fig 4 - Breakdown of costs for different strategies of duodenal ulcer treatment over 15 years (medical treatment using ranitidine)

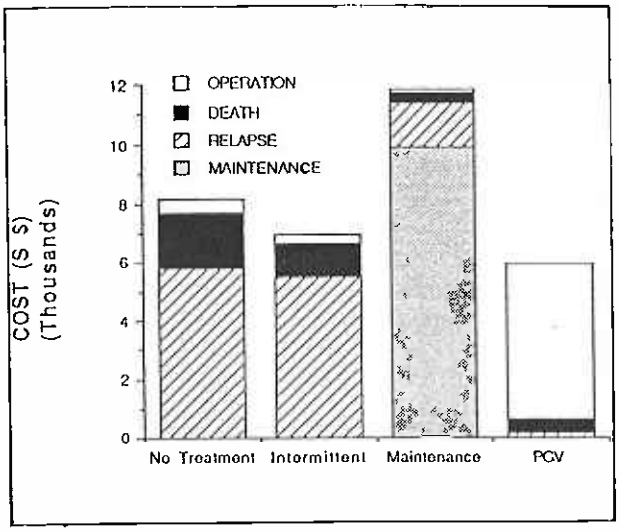


Table I
Rates and costs used in the present study

Monthly rate & results of surgery	Baseline assumption (%)	Range used in sensitivity analysis (%)
Spontaneous healing rate[1]	43	-
Healing rate under H2 blockade[1, 6, 7, 9]	77	70-84
Spontaneous recurrence rate[1]	8.5	-
Recurrence rate under H2 blockade[1, 10]	2.5	0.25-4
Recurrence rate after proximal gastric vagotomy[11]	0.25	0.1-1.0
Incidence of emergency operation[5]	0.3	-
Results of emergency operation[5]		
Death (30%)	0.09	-
Visick grade IV (7%)	0.021	-
Visick grades I-III (63%)	0.189	-
Initial results of proximal gastric vagotomy[12-15]		
Death	0.3	0.15-1.2
Visick grade IV	5	2-8
Visick grades I-III	94.7	-
Future costs discount[4] (yearly)	3	2-10
Costs of ranitidine therapy (monthly)		S$114.00
Elective proximal gastric vagotomy		S$4618.00
Partial gastrectomy		S$5324.00
Mean income (monthly) (All working persons, age > 10)		S$824.00

patient on maintenance treatment rises from $800 after one year to $12,000 after 15 years. Intermittent therapy and no therapy cost $390 and $400 after one year, $7,000 and $8,200 after 15 years. Proximal vagotomy costs range from $4,700 after one year to $6000 after 15 years (Fig 2).

Surgery incurs a large cost both monetary and in terms of mortality initially, with very little increase in costs after. Maintenance treatment incurs cumulative costs so that the total cost catches up with surgery after approximately 7 years (Fig 2). The same is true of deaths due to ulcer disease using the two strategies (Fig 3). Fig 4 shows the contribution of the different factors to the overall costs of the various treatment strategies. With no treatment or intermittent treatment the costs of ulcer relapse contribute most to the total costs. For maintenance therapy and surgery, on the other hand, most money is spent on the costs of long-term medication and initial surgery respectively.

The rate of ulcer healing (within the range 70-84% at 4 weeks) has a minimal effect on the costs of maintenance treatment (Fig 5a). Reducing the recurrence rate on maintenance therapy to 0.25% per month[8] reduces costs to $700 and $10,200 after one and 15 years respectively (Fig 5b). On the other hand, proximal vagotomy costs are insensitive to changes in recurrence rates (Fig 5b). If the frequency of unsatisfactory outcomes (Visick 4) after proximal vagotomy was worse than assumed elective surgery can cost $4,700 and $6,400 after one and 15 years, respectively (Fig 5c). Increasing the monthly death rate after proximal vagotomy from 0.15% to 1.2% increases the overall cost of surgery from $5,800 to $7,300 after 15 years (Fig 5d). Increasing yearly discount rates from 2% to 10% marginally affects future costs calculations for proximal vagotomy and maintenance after 15 years (Fig 5e).

DISCUSSION

In the American medical system maintenance and intermittent treatment cost only about 60% as much as surgical treatment. In the West German system maintenance treatment costs approximately twice as much as surgical treatment after 15 years : the cost of intermittent treatment being intermediate.

The situation in Singapore is similar to that in West Germany. After one year surgery costs six times as much as maintenance treatment. After seven years the costs of the two options are similar while after 15 years maintenance treatment costs twice as much as surgical treatment. Again intermittent treatment incurs intermediate costs (Fig 2).

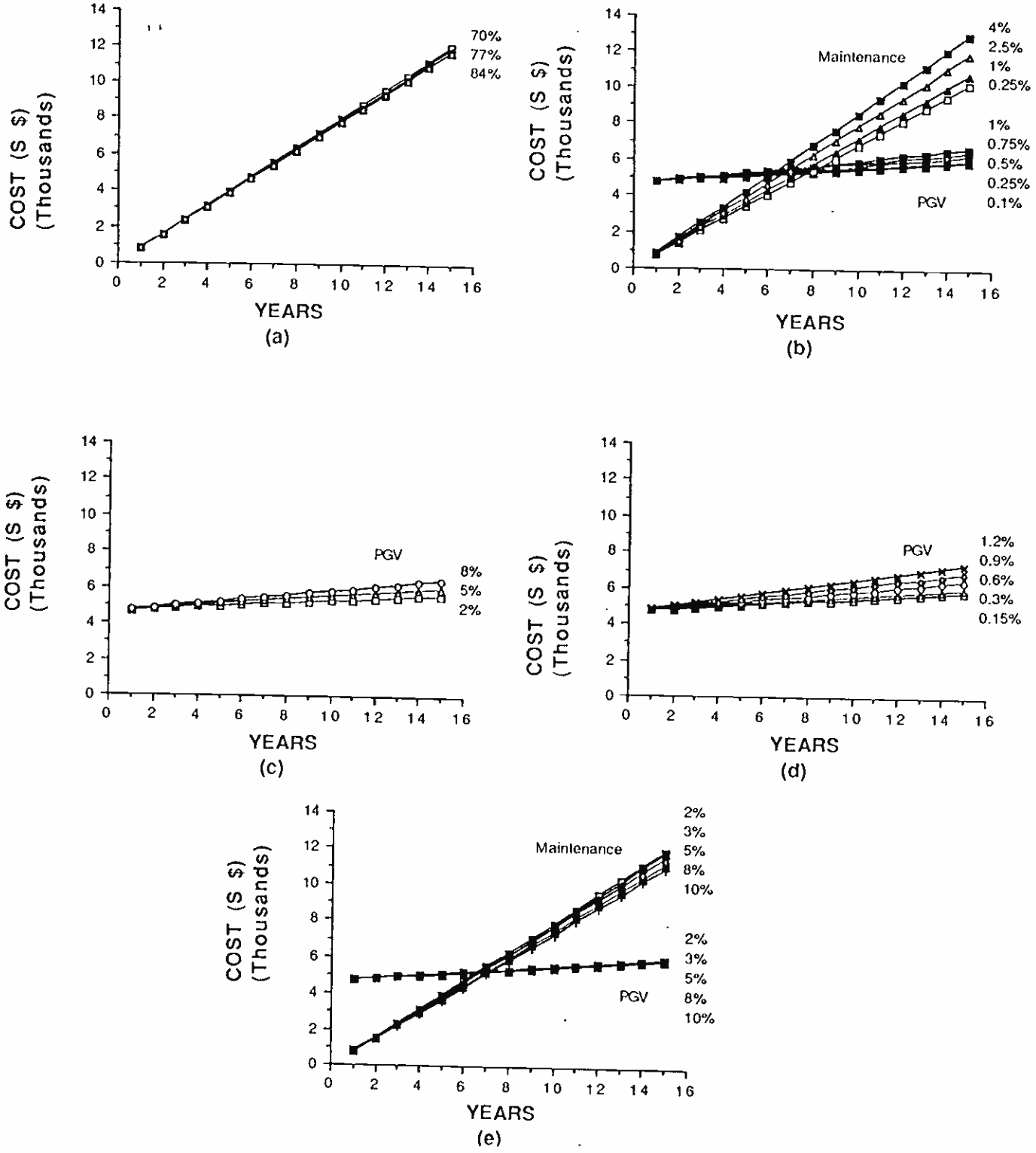
Several variables need to be considered. Based on a spontaneous monthly recurrence rate of 8.5% the average patient relapses about once a year. Patients relapsing less often would benefit financially from intermittent treatment whereas patients relapsing more frequently would do better on maintenance treatment.

The figures relating to the results of proximal vagotomy are those from major centres. Proximal vagotomy is a technically difficult surgical procedure with a large variability in operative results among different surgeons. Since the advent of histamine-2 antagonists there has been a marked decline in prevalence of elective ulcer surgery. Fewer and fewer surgeons are going to become experienced in this technique and consequently poorer results could be expected.

The costs of medication may be expected to fall in future years, as more and different types of ulcer medication preparation come on the market and as patents run out. This will have a major impact on reducing the costs of medical treatment. Currently for example cimetidine is available in generic form. This costs significantly less than the original preparation. Using this preparation (200 mg costing S$0.10), the cost of maintenance treatment over 15 years would be approximately 45% that of surgery (Fig 6).

In the final analysis, the patient's ulcer course and patient and doctor preference will determine the choice of therapy in an individual patient. However, cost-effectiveness considerations as oulined here may help the physician to make his or her decision more rationally.

Fig 5
Sensitivity Testing



(a) Effect of varying ulcer healing rates on costs of maintenance therapy

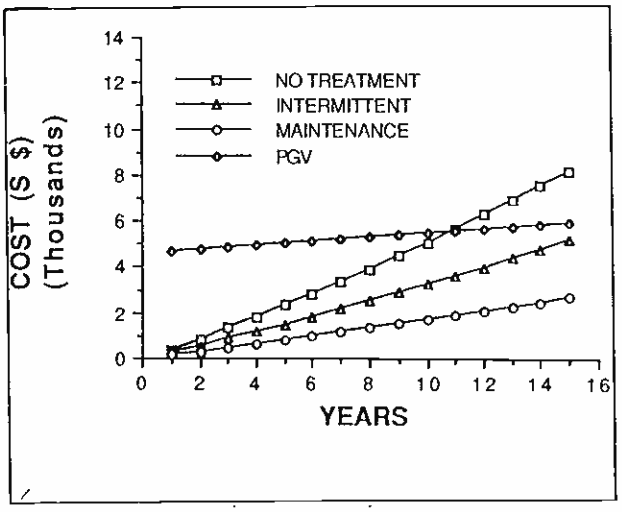
(b) Effect of varying recurrence rates on costs of maintenance therapy and proximal gastric vagotomy respectively

(c) Effect of varying Visick 4 on costs of proximal gastric vagotomy

(d) Effect of varying mortality rates on costs of proximal gastric vagotomy

(e) Effect of varying yearly discount rates on future costs of maintenance therapy and proximal gastric vagotomy respectively.

Fig 6 - Cost of medical treatment using a generic H2 antagonist preparation



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