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COST-EFFECTIVENESS OF CT, EUS AND PET/CT IN EVALUATING PATIENTS WITH SYMPTOMS OF PANCREATIC CANCER IN COLOMBIA

Oscar Gamboa [1], Liliana Alejandra Chicaiza y Mario Garcia-Molina [2]

Abstract

Introduction: An estimated 1,399 new cases of pancreatic cancer (PC) and 1,406 deaths from the same cause occurred in Colombia in 2002. We evaluate the cost-effectiveness of multidetector computed tomography (CT), endoscopic ultrasonography (EUS) and positron emission tomography with computed tomography (PET/CT) in diagnosis and staging of patients with clinical suspicion of PC.

Materials and methods: We conducted a cost-effectiveness analysis based upon a systematic search to determine the strategies' sensitivity and specificity. The costs of administering and monitoring were taken from the official tariff manuals. The results were assessed in terms of number of correct behaviours. We performed deterministic and probabilistic sensitivity analyses.

Results: CT showed the best cost-effectiveness indicator (Col$ 3,397,163 for each appropriate behaviour). The cost of changing the strategy to that of CT plus EUS was Col$ 7,893,573 for each additional appropriate behavior. In the probabilistic analysis the cost-effective strategy was USE for a willingness to pay higher than Col$ 9,000,000 per additional unit, or TAC for smaller values.

Conclusion: The cost-effective strategy in the evaluation of patients suspected PCis the multidetector CT. For values of willingness to pay more than Col$ 7,893,573 and Col$ 9,000,000 per additional unit cost-effective alternatives are EUS or CT plus EUS in series.
Keywords: Pancreatic neoplasms, Diagnosis, Radiology, Cost-Benefit Analysis (Source *MeSH,* Pubmed)

***Key words*:** Predator – prey model, Non – linear dynamic behavior, Demand cycles, Employment, Distribution.

JEL classification: D61, I11, I12, I19

[1] National Cancer Institute.
[2] Faculty of Economic Sciences, Universidad Nacional de Colombia.

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1. Introduction

Pancreatic cancer (PC) is responsible for approximately 40,000 deaths annually in the United States and Europe (1-2). 1,399 new cases and 1,406 deaths from this disease were estimated for Colombia in 2002 (1). Surgery is currently the only curative option for these patients; however, many of them develop early recurrence of the disease within the first 6-12 months after surgery. The poor prognosis is related to the aggressive characteristics of the disease and the presence of extra-pancreatic tumours not found during the assessment prior to surgery.

Multidetector CT, endoscopic ultrasonography (EUS) and more recently positron emission tomography over computed tomography (PET/CT) are used as diagnostic tools in the staging of the disease, whose objective is to determine tumor resectability and the metastasis detection. Assessment of tumor resectability has important implications for surgical management, because a resectable tumor undergoes surgery with curative intent, which has a high morbidity with no benefits in patients with unresectable or metastatic PC (3-5).

This study aims to assess the cost-effectiveness of using CT, EUS and PET/CT in the diagnosis and management of patients with clinical suspicion of PC on the setting of the Colombian population.

Methodology

To evaluate the cost-effectiveness of diagnostic strategies in patients with suspected PC, we built a decision tree to evaluate the following strategies: 1) EUS, 2) multidetector CT and 3) PET/CT, 4) CT plus EUS used in series or in parallel (Figure 1). The model took into account the sensitivity and specificity indicators for cancer detection and resectability assessment for each of the diagnostic tests included. As a measure of effectiveness we used the number of appropriate treatment behaviours, considering a proper conduct when the diagnostic test detects the PC and adequately assesses it as resectable or unresectable. The time horizon was less than one year (time from initial evaluation until histological confirmation of resectability after surgery). No discount rate was applied because the time horizon was short.

Clinical data

We conducted a systematic literature review, which extracted sensitivity and specificity data for detection of PC and resectability for each of the diagnostic tests. The PC prevalence data in patients with clinical suspicion of this disease, and the proportion of tumors that are resectable were obtained from locally conducted studies (6-12).

Table 1 shows the parameters used in the model with the respective ranges used in sensitivity analysis.

Cost data

The perspective was that of the third payer, and we only included direct costs related to the administration of the tests, diagnostic procedures, surgical treatment and management of complications (Table 2). Costs were calculated according to the tariff rates of the official insurance handbook (SOAT).

Economic Analysis

We estimated the incremental cost-effectiveness ratios (ICER), built the efficiency curve, performed univariate and probabilistic sensitivity analysis for cost and clinical data, and calculated the acceptability curves and confidence regions on the effectiveness plane.

Results

The PET/CT strategy was more costly and less effective, taking appropriate behavior in only 69.2% of cases. The strategy based on CT plus EUS used in series to assess resectability was the most effective in taking the appropriate behavior for 79.7% of cases (Table 3).

The strategy based on CT alone had the best cost-effectiveness ICER (Col$ 3,397,163 for each appropriate behaviour), the cost of changing this strategy to CT plus EUS used in series was Col$ 7,893,573 for each additional appropriate behaviour gained.

Figure 2 shows the efficiency frontier. The strategies with multidetector CT and CT plus EUS used in series fall on the curve, while that the strategies PET/CT, CT plus EUS used in parallel and EUS alone are dominated.

Sensitivity analysis

Univariate analysis of costs showed that costs per hospitalization day, the cost of pancreaticoduodenectomy and cost of CT are the variables that affect the cost-effectiveness ratios. For costs per hospitalization day lower than Col$ 175,000, EUS becomes a cost-effective strategy; and for cost for CT higher than Col$ 1,270,000, the cost-effective strategy is EUS.

The clinical variables affecting the cost-effectiveness ratios are: the specificities of CT and EUS to assess resectability, the prevalence of PC in patients with clinical suspicion, the sensitivity of CT for the detection of PC, and the proportion of PC cases resectable at diagnosis. For a specificity of the assessment of resectability of CT below 53% and above 70% for EUS, prevalence of cancer less than 76% and PC ratios resectable at diagnosis greater than 50%, the strategy is EUS becomes efficient and TAC plus EUS strategy ceases to be efficient and becomes a dominated strategy.

Probabilistic sensitivity analysis

We performed 10,000 Monte Carlo simulations. Figure 3 shows the confidence region on the plane of incremental effectiveness for CT plus EUS in series compared with multidetector CT. For WTP per additional unit of effectiveness of Col$ 7,600,000, the strategy of CT plus EUS serial is cost-effective in 50% of the simulations (area below the diagonal), indicating that for this threshold there is uncertainty about whether this strategy is cost-effective.

Figure 4 shows the acceptability curves for different management strategies in patients with clinical suspicion of PC. For a WTP per additional effectiveness unit greater than or equal to Col$ 9,000,000 the cost-effective strategy is EUS, whereas for smaller values CT becomes cost-effective.

Conclusions

Assessment of resectability of pancreatic tumours at diagnosis is important in determining the surgical procedure with curative intent and due to the significant occurrence of this type of tumour in the Colombian population is important for the economic analysis of different diagnostic alternatives to be funded by the health system.

Several studies have demonstrated the cost-effectiveness of imaging in determining resectability of pancreatic tumours on imaging methods (6, 13-14), but had not compared the three PC diagnostic imaging procedures.

From the economic point of view the cost-effective strategy for assessing patients with clinical suspicion of PC is multidetector CT at a price for examination up to Col$ 583,773. Diagnosis/ staging of PC based CT plus EUS used in series or EUS alone to assess resectability become cost-effective for WTP higher than or equal to Col$ 7,893 573, and Col$ 9,000,000, respectively.

The limitations of this study are related to the dependency of the estimates of cost-effectiveness on indicators that were estimated from the literature because, although their precise values are different for each strategy, the ranges overlap in some cases. In the case of the parameters of sensitivity and specificity of CT and PET/CT, this may result in no differences in diagnosis, as the probabilistic analysis could not find significant differences. Furthermore, the studies included in this study estimated the parameters for patients with symptoms of pancreatic cancer, but in Colombia the diagnosis is usually made in advanced stages of disease where the prognosis is more discouraging (12).

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Table 1. Parameters used in the economic evaluation of the diagnosis of operable pancreatic cancer.

	Base%	Rank sensitivity analysis %		Reference
Cancer				
PET-CT Sensitivity	84.0	68.0	100.0	(6-8)
PET-CT Specificity	88.0	76.0	100.0	(6-8)
TAC Sensitivity	86.0	72.0	100.0	(9-10)
TAC Specificity	88.8	77.6	100.0	(9-10)
EUS Sensitivity	98.0	96.0	100.0	(10-11)
EUS Specificity	92.0	84.0	100.0	(10-11)
Resectability				
PET-CT Sensitivity	81.0	62.0	100.0	(6-8)
PET-CT Specificity	72.7	45.4	100.0	(6-8)
TAC Sensitivity	92.0	84.0	100.0	(9-10)
TAC Specificity	64.0	28.0	100.0	(9-10)
USE Sensitivity	88.0	76.0	100.0	(10-11)
EUS Specificity	68.0	36.0	100.0	(10-11)
Cancer Prevalence	77	70	90	(6-11)
Proportion of unresectable cancers at diagnosis	50	40	60	(6-11)
Pancreaticoduodenectomy Complications				
Risk of fistula	4.60	2.3	9.2	(12)
Risk of abscess	3.10	1.6	6.2	(12)
Risk of Ileus	1.50	0.8	3.0	(12)
Hospitalization days with no complications after surgery	10	8	12	Expert
Hospitalization days after surgery with complications	22	15	30	Expert

Table 2. Cost data used in economic evaluation

	Base	Range sensitivity analysis	
Multidetector CT cost	Col$ 583,733	Col$ 447,467	Col$ 720,000
Endoscopic biopsy ultasonografía cost	Col$ 1,153,683	Col$ 1,069,820	Col$ 1,237,547
PEC-TAC cost	Col$ 3,875,000	Col$ 1,937,500	Col$ 7,750,000
Pathology study cost	Col$ 53,674	Col$ 26,837	Col$ 80,512
Exploratory laparotomy cost	Col$ 722,410	Col$ 361,205	Col$ 1,083,614
Surgical treatment with curative intent			
Pancreaticoduodenectomy	Col$ 1,615,050	Col$ 1,076,700	Col$ 2,153,400
Pancreaticoduodenectomy Complications			
Fistula	Col$ 1,002,946	Col$ 1,337,261	Col$ 668,631
Abscess	Col$ 654,257	Col$ 436,171	Col$ 872,342
Daily cost of Ileus hospitalization	Col$ 205,273	Col$ 136,849	Col$ 273,697
Surgical palliation			
Pancreatic biliary	Col$ 1,889,285	Col$ 1,259,524	Col$ 2,519,047
Daily cost of hospitalization	Col$ 205,273	Col$ 136,849	Col$ 273,697

Table 3. Costs, % of appropriate behaviors, reasons of cost-effectiveness and incremental cost-effectiveness of different strategies for management of patients with clinical suspicion of pancreatic cancer

Strategies	Cost	Incremental Cost	Effectiveness	Incremental effectiveness	C / E	ICER
Multidetector CT	Col$ 2,427,748.20		71.5%		Col$ 3,397,163	
EUS TAC + series	Col$ 3,075,780.00	Col$ 648,031.80	8.2%	79.7%	Col$ 3,860,475	Col$ 7,893,573
EUS	Col$ 3,120,477.40	Col$ 44,697.40	79.6%	-0.1%	Col$ 3,922,563	(Dominated)
TAC + EUS parallel	Col$ 4,243,251.50	Col$ 1,167,471.50	74.1%	-5.6%	Col$ 5,728,675	(Dominated)
PET / CT	Col$ 6,380,474.60	Col$ 3,304,694.60	69.2%	-10.5%	Col$ 9,223,538	(Dominated)

Figure 1. Decision model for evaluation of the cost effectiveness of diagnosis of resectable pancreatic cancer.

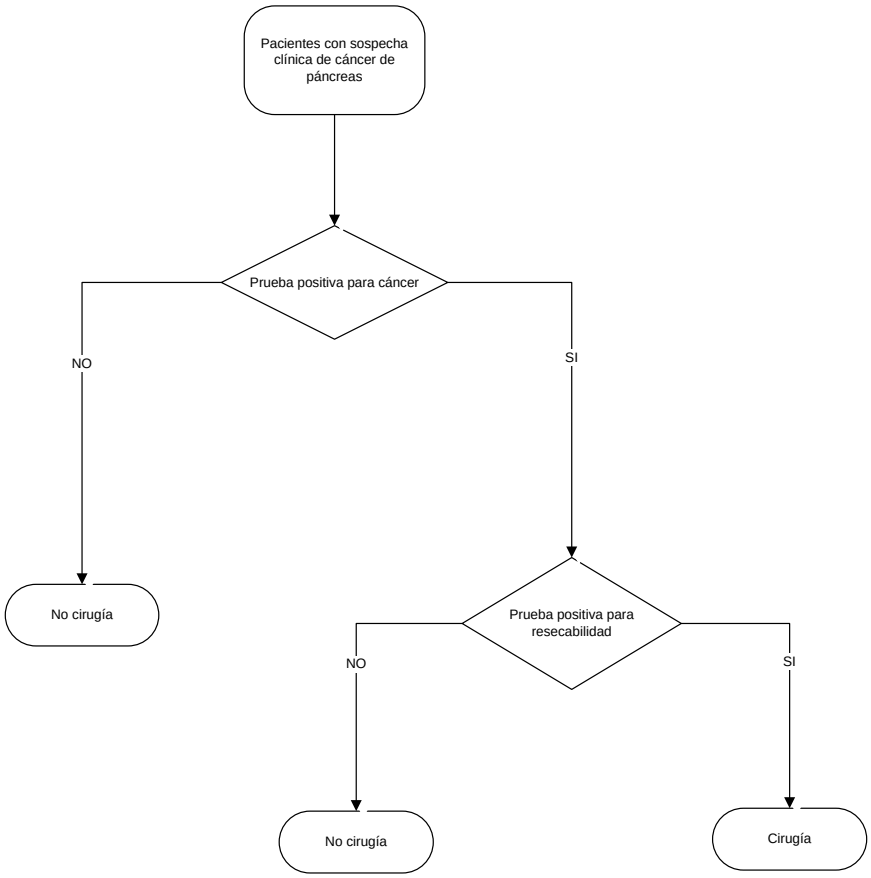

Figure 2. Efficiency frontier on the percentage of appropriate behavior

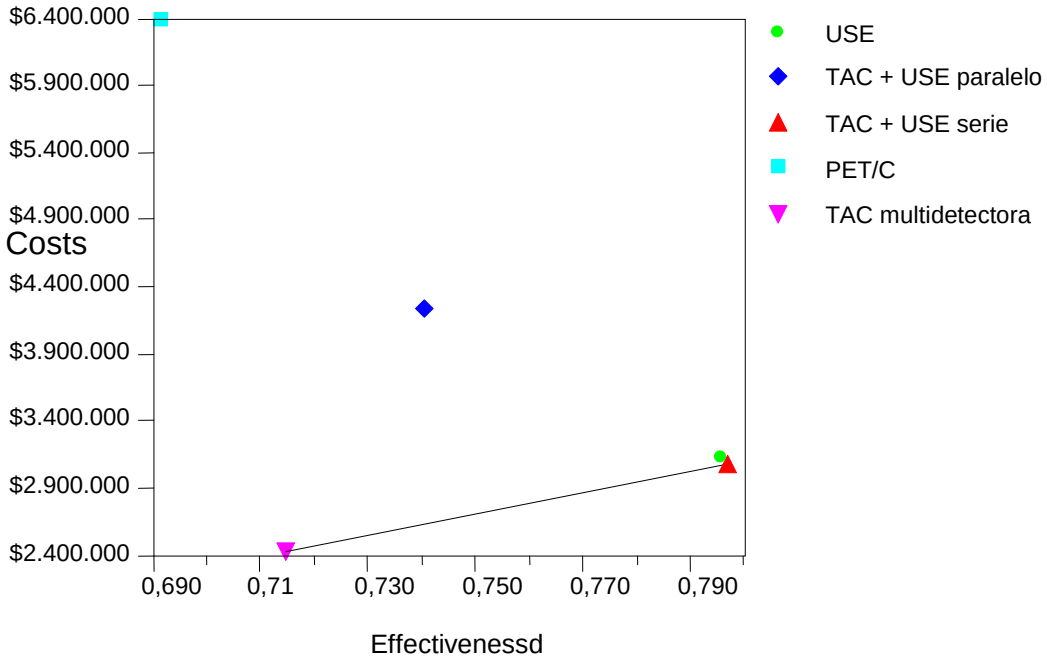

Figure 3. Confidence regions of the probabilistic analysis of the comparison of CT + EUS vs series. Multidetector CT.

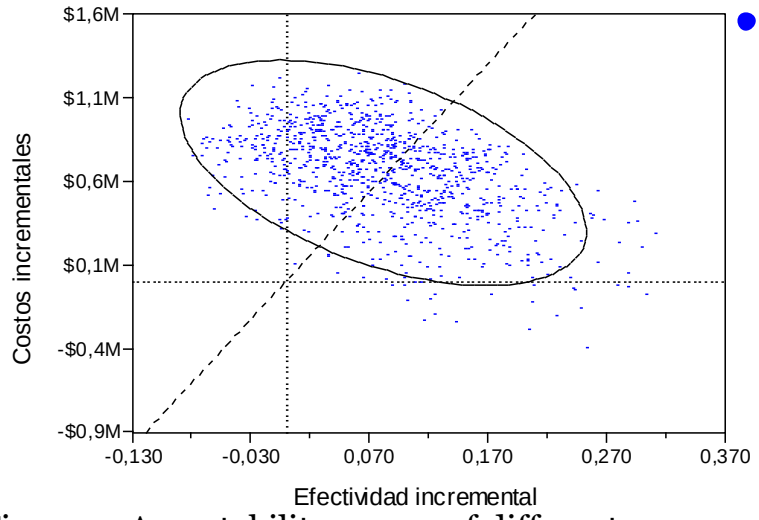

Figure 4. Acceptability curves of different management strategies for patients with clinical suspicion of pancreatic cancer.

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